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DR. NANSEN'S FIRST CROSSING OF GREENLAND.*

By E. CLODD.

DR. NANSEN tells the story of his perilous driftings amidst the ice-floes, and of his only less risky journey across the ice-fields of Greenland, in a cheery, straightforward way that wins admiration, and that shows him well-equipped in forethought and scientific training for a task which, as his article in the November number of *Longman's Magazine* informs us is, after all, only a preliminary canter before undertaking in 1892 the oft-repeated endeavour to reach the North Pole and wrest from nature one of her few remaining secrets.

To make beginning and end of fault-finding with these sumptuous volumes, we may at once say that they would have been more attractive to the general public, with its unreasoning impatience of detail, if Dr. Nansen had thrown the earlier chapters on the equipment of his expedition, on the history of earlier attempts to cross Greenland, and on kindred matters, into his appendix, and made straight for his story, which, in brief outline, is as follows.

A voyage made by Dr. Nansen in a whaler in 1882, when he was in his twenty-second year, suggested the attempt to enter Greenland from the east side and cross the inland ice to the west, "skilobning" or "ski-running" some 300 miles. The "ski," to which Dr. Nansen devotes a long chapter, graphically illustrated, are in universal use in Scandinavia and Lapland, and consist of two narrow iron-shod pieces of wood, fastened by loops and bands to the feet. The skilober slides forward, balancing himself by a short pole, which he also uses as a propeller to increase the length of the stride, and by this simple contrivance an expert can travel eight or nine miles an hour over fairly good snow.

Undeterred by croakers and prophets of evil, Dr. Nansen set to work, engaged three Norwegians and two amusing grumbling Lapps, and arranged with the captain of the steam-sealer *Jason* to pick up the party at Iceland, and drop them, with their boat and equipment, on the floe-ice off Greenland, which coast was sighted on the 11th of June 1888. But, as Dr. Nansen had to await the convenience of the sealer as to time and place of landing, some weeks passed before this was effected, the delay giving occasion for an interesting chapter on the bladder-nose seal, its habits and mode of capture. And here, wittingly or not, in referring to the failure of the seal-fishery in recent years, Dr. Nansen makes an important contribution to the solution of the problem of heredity. For as the decrease in the number of seals is not so great as was

SHOOTING BLADDER-NOSED SEAL.

formerly supposed, the failure of the industry must be due to an alteration in the mode of life of those animals resulting from experience of past dangers, and perhaps also from the imperious conditions of the universal struggle for existence. If the former be in any degree a cause, Dr. Weismann's theory of the nonheritability of acquired habits falls to pieces. And the striking feature cited by Dr. Nansen is that "not only have the old seals grown shy, but the younger seals have become astonishingly wary. The parents must have imparted their experience to the offspring, or the same result must have been brought about by heredity, though this seems scarcely likely to have happened in so short a time." Of course the least shy would be soonest killed, leaving the more wary ones to survive under the agency of natural selection; but the fact remains that, "in the short space of a decade," the seal has learnt to protect itself from an enemy hitherto unknown.

At last, on July 17th, the *Jason* disembarked the doctor and his comrades, with a couple of boats, not on *terra firma*, but on an ice-block! On that slippery, rudderless craft, carried hither and thither by polar currents, one day as much as thirty miles seaward, they pitched their tent, hauled up the boats, set the "watches," and awaited the

* *The First Crossing of Greenland.* By Fridtjof Nansen. Translated from the Norwegian by H. M. Jepp, B.A. Two vols. London: Longmans & Co., 1890.

lucky chance that should drift them near enough to launch their boats and row to land. The life on board the various floes to which from time to time they transferred themselves is graphically told; and the weird, desolate scenery, its monotony broken only by the play of light on majestic and fantastic moving icebergs, and by crash of colliding floes, is vividly set before us, awaking memories of the ghostly vision of Coleridge's "Ancient Mariner."

The party effected a landing on August 13th, in a bay

NIGHT AMONG THE FLOES.

near Umivik, and their arrival was the sensation of an Eskimo encampment hard by. After delighting these kind folk with souvenirs in the shape of empty preserved-meat tins and needles, the boats were abandoned, the sledges loaded, and the mosquito-maddened expedition began its toilsome ascent to the interior, up steep slopes of rugged ice, over fissures and snow-bridged crevasses, with now and then relief in level plateau; one day drenched by rain, another day nearly engulfed in snow, and every day battling with

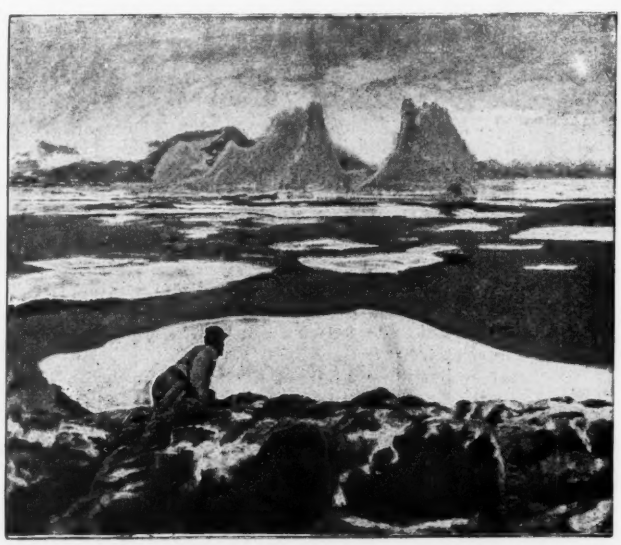
VIEW OVER THE INLAND SEA.

the frost giant, whose sway Dr. Nansen and his comrades had been the first Europeans to dispute at such altitudes in Greenland; for they finally reached a height of 9,000 feet, whence the ice-field sloped more gently to the western coast. This inland journey was more monotonous than the navigation among the floating ice, for an infinite ice-desert, relieved here and there only by "nunataks," or peeping heads of bare rocks, was around them in its blinding whiteness.

And yet, where the ice now lay in massive thickness, there once flourished plants, species of which now grow only within the latitude of Egypt; forests of palms and other tropical plants in one series of Tertiary deposits; and of conifers, oaks, alders, and figs in another series of like deposits. When favouring winds blew, the speed of the sledges was quickened by lashing them together and hoisting sails on them; and at last, on September 25th, the unwashed and weary party reached Ameralekfjord, and by aid of a rudely constructed boat arrived at Godthaab, but too late to catch

SLEDGE-SAILING IN MOONLIGHT.

the last steamer to Denmark before the winter season. Messages of their safe arrival were sent 300 miles south by an Eskimo to the captain of the *Fox*—the ship in which McClintock sailed in his search for Franklin—and then the party settled down to spend the winter in Greenland



COLOSSAL ICEBERG OFF NAGTORALIK.

in halibut-fishing and seal-hunting in "kayaks," and in excursions to the interior. Dr. Nansen utilised his stay in studying the manners and customs of the Greenlanders, and in watching the effect of Danish rule and missionary effort among them. This has added a valuable chapter to the book, and supplied further material for reflection

upon our pernicious "civilising" of barbaric peoples. Danish administration has abolished the old customs of a cheerful, free-hearted folk, and given them nothing in their stead; it has placed the rifle in their hands, and thus brought about the disuse of harpoon and dart; it has led them to exchange the native seal-skin dress for European cotton, and thus increased the fatal disease of consumption amongst a once fitly-clothed but now shivering people. As for the missionaries, they have done their best to abolish dancing, but Dr. Nansen reports himself unable to trace any improvement in the easy morals of the Eskimo through missionary influence.

The scientific reader is laid under obligation by the valuable appendices on the geology of Greenland, and on the results of the expedition, while he will find matter of contention in Dr. Nansen's theories of glacial action. The volumes are lavishly illustrated, the woodcuts being reproductions of photographs and drawings furnished by the author, to whom his eminent publishers have done ample justice.

PRIMEVAL SALAMANDERS.

By R. LYDEKKER, B.A.Cantab.

IF we assume that naturalists are right in regarding evolution as the true explanation of the mutual relationships of living beings, and if we also take it for granted that fishes are the lowest representatives of vertebrated animals of which we have at present any cognizance, we should naturally expect to find in some of the lower rocks, at a period when fishes had already obtained considerable development, remains of animals in some respects connecting fishes with reptiles. This expectation is fully realised by the presence in the coal-measures and lower secondary rocks of a remarkable group of totally extinct animals, which may be popularly termed Primeval Salamanders, since their nearest living allies are to be found in the Efts of our own ponds, in the well-known yellow-and-black Salamanders of the Continent, and in the so-called Giant Salamanders of Japan and the United States, with the latter of which we have become more or less familiar of late years by means of aquaria.

It may save trouble, before going farther, to mention that although Salamanders and their kin are popularly spoken of as reptiles, yet they have really no right to such a high rank, since they show many signs of relationship with fishes, all of which are quite lost in recent reptiles. These creatures should rather be spoken of as Amphibians, by which title we shall henceforth allude to them when we desire to speak of them in a collective sense. Frogs and toads are likewise members of the same great group, of which one of the most distinctive features is that during their lives they pass through a metamorphosis—thus changing from a purely aquatic creature (the tadpole) without limbs, and breathing by means of gills like a fish, to one which becomes capable of progression on land, with two pairs of legs, and breathing either entirely or partially by means of lungs, the gills being in some cases completely lost (as in the frog), but occasionally retained as subsidiary breathing organs. This change or metamorphosis, we may remark in passing, is of itself almost sufficient to prove the doctrine of evolution, being, in fact, nothing less than the actual transformation, under our very eyes, of a creature a little higher than a fish into one but little lower than a reptile; so little lower, indeed, that, as we have said, it popularly obtains brevet rank in that group. A feature by which the skull of an Amphibian can always be distinguished from that of a Reptile, at a glance, is found in the mode in which it articulates with the first joint of the back-bone or vertebral column. Thus, in Amphibians, as shown in Fig. 2, the hinder or occipital region of the skull is furnished with two processes, or condyles, which are received into a pair of cups in the first joint of the back-bone; an arrangement—and this is a very significant point—similar to that which obtains in Mammals. In Reptiles (and likewise in their near relations, the Birds), on the other hand, there is but a single knob-like occipital condyle, situated in the middle line, and received into a single cup in the first joint of the back-bone.

With this preliminary explanation we may proceed to the consideration of the Primeval Salamanders. In this country the first evidence of the bony skeleton of these creatures that was brought under notice was afforded by teeth from the New Red Sandstone (at the lower part of the secondary system of rocks) of Warwickshire and Cheshire. These teeth, which are of conical form, are remarkable for the circumstance that when a transverse section of their base is made, and examined under a lens or a microscope, the whole of the internal portion is seen to be made up of a most complex series of foldings, forming a peculiar and characteristic labyrinth-like structure. From this feature the veteran comparative anatomist, Sir R. Owen, proposed the name of Labyrinthodonts, or Labyrinth-toothed Saurians, for the owners of these remarkable teeth; and although some of the smaller species which have been subsequently discovered do not exhibit the same complexity of tooth-structure, this name may well be adopted as the technical designation of the whole group. By a masterly piece of induction the great anatomist also showed that certain gigantic skulls of the type of the one represented in Fig. 2, which had been discovered at an earlier date in the corresponding rocks of Germany, and whose owners have been named Mastodonsaurs, belonged to other species of the same group. It was further known at the same time that some curious hand-like footprints of a large unknown animal, for which the name of Chirothere (Hand-animal) had been proposed, were of not uncommon occurrence in the Cheshire and Warwickshire sandstones, and the idea naturally occurred that these were the tracks of Labyrinthodonts. Now, it is highly probable, although not absolutely certain, that this conjectural association of the tracks with the teeth and skulls is a true one; but, most unfortunately, the evil genius of the Professor led him

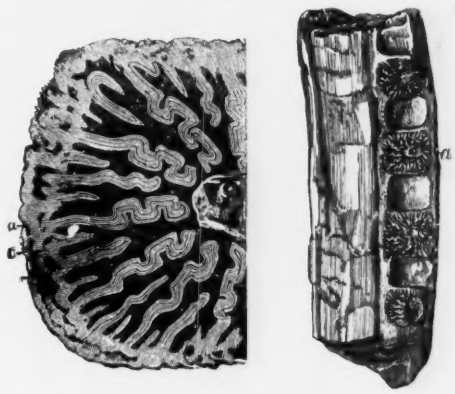


FIG. 1.—*A*. FRAGMENT OF JAW OF A PRIMEVAL SALAMANDER, SHOWING SECTIONS OF FOUR TEETH. *B*. One half of a tooth (*a*) greatly magnified.

to sketch a restoration of the Labyrinthodont, or Chirothere formed on the model of a gigantic frog; and although it was subsequently shown that the idea of a frog with a skull of a yard in length was totally impossible, yet, with the tendency of all errors to perpetuate themselves, we still see books (even some of them published within the last two or three years) disfigured by reproductions of this impossible tailless creature.

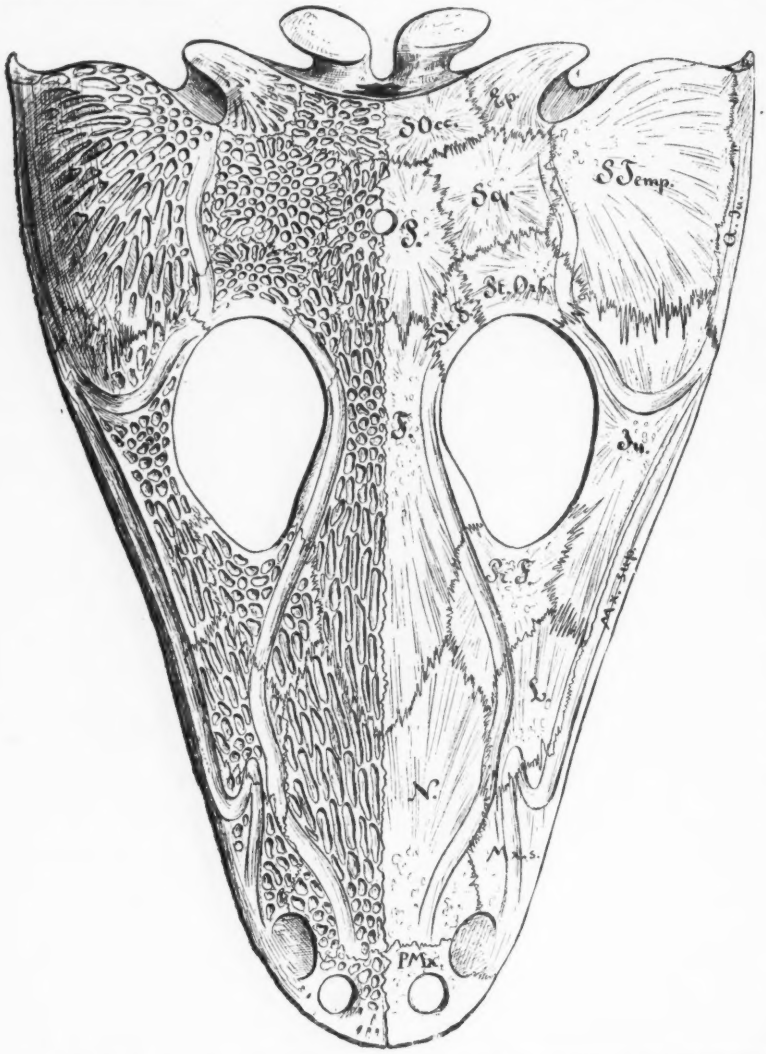


FIG. 2.—SKULL OF THE GIANT PRIMEVAL SALAMANDER (*Mastodon-saurus*), one-fifth natural size. *S.Occ.*, supra-occipitalbone; *Ep.*, epiotic; *P.*, parietal; *Sq.*, squamosal; *S. Temp.*, supra-temporal; *Pt.F.*, post-frontal; *Pt.Orb.*, post-orbital; *F.*, frontal; *Pr.F.*, pre-frontal; *N.*, nasal; *P.Mx.*, pre-maxilla; *Mx.Sup*, maxilla; *L.*, lachrymal; *Ju.*, jugal; *Q.Ju.*, quadrato-jugal. On the right side of the skull (left side of Figure) the external sculptured layer of bone is shown, which is omitted on the left in order to show the contour of the individual bones. The large apertures are the eye-holes or orbits; the smaller shaded apertures in front, the nostrils; and the smallest of all holes for the points of the tusks of the lower jaw. The projecting processes at the top of the Figure are the occipital condyles. (*After Fraas.*)

Instead of the Primeval Salamanders being modelled on the lines of a frog, they were, indeed, constructed after the fashion of a modern Eft or Salamander, having, in the adult state, four limbs adapted for walking, and a well-developed tail. Nearly the whole of them differed, however, from modern Salamanders in that the chest was defended by an armour of three bony plates—one central and two lateral—ornamented with a sculpture similar to that shown in the skull represented in Fig. 2. In addition to this, other species had the whole of the under surface of the body protected by a series of bony scales, arranged in a chevron pattern; while in a few rare instances the whole of the body was covered with an armour of these bony scales. We thus see that the earlier members of this group come under the designation of mail-clad animals, of which we have treated in a previous article.

Another absolutely distinctive feature of the Primeval Salamanders is to be found in the structure of the skull. It will be seen from Fig. 2 that the whole of the upper surface of the skull behind the eye-holes, or orbits, is covered by a complete bony roof, extending continuously from the bone marked *S*, which immediately covers the brain-case, to the sides of the hinder part of the jaws. If we compare the skull of a crocodile with the figure, we shall find, in place of this continuous roof, a long open channel cut from behind each orbit in the direction of the bone marked *S. Temp.* to the back of the skull, while there are also a pair of oval vacuities in the region of the bones marked *Sq.* A Lizard has the hinder part of the skull still more completely opened out. The completely roofed skull of the Primeval Salamanders appears, indeed, to show signs of affinity with some of the earlier fishes; and there seems to have been a gradual tendency among Reptiles to emancipate themselves from this type of skull as time went on. For instance, the Fish-Lizards (Ichthyosaurs), which show signs of direct connection with the Primeval Salamanders in the somewhat folded internal structure of their teeth, and in their simply-cupped vertebræ, are also those reptiles which exhibit the nearest approximation to this roofed type of skulls; while the modern and highly specialized Lizards are those which depart most widely from it. It may be worth mention that some of those naturalists who are never satisfied with a name, unless it be one for which they are personally sponsors, have proposed to replace the well-established name of Labyrinthodonts by that of Stegocephalians, or Roof-skulled Saurian—a term sufficiently appropriate if no earlier one had barred the way to its adoption.

Another peculiar although not absolutely characteristic feature of the skull of the Primeval Salamanders is the net-like sculpture with which the external surface of all the bones is ornamented (Fig. 2). The reappearance of a

similar sculpture in the skulls of Crocodiles has suggested that those reptiles may trace their ancestry directly back to the group under consideration. We must not, however, omit to mention the small round aperture which occurs in the bones of the skull immediately over the brain-cavity in all Primeval Salamanders, and is seen to the left of the letter *S* in Fig. 2. This aperture corresponds to one found in the skull of that curious New Zealand Lizard known as the Tuatara, which is one of the most primitive reptiles now living, having but little affinity with true lizards. In that creature this aperture overlies the rudiment of an eye now totally useless and lying deep down in the brain, but which was probably functional in the earlier ancestors from which the Tuatara sprung. The comparatively large size of this aperture in the Primeval Salamanders suggests the possibility that the central cyclopean eye may still have been capable of receiving some impressions of light, although it is probable that we should have to go back to some long lost invertebrate ancestor before we found it of any real use to its owner.

The majority of the Primeval Salamanders had their back-bone composed of biconcave joints much like those of ordinary fishes, or Fish-Lizards. In some of the earlier and most primitive forms the body of each joint of the back-bone was, however, composed of three separate pieces; and since a very similar peculiarity is found in certain primitive fishes, we have again evidence of the close affinity existing between these two groups of animals.

The amphibians forming the group under consideration made their earliest appearance, so far as our present knowledge entitles us to speak, at the early part of the great Coal Period. Thence they were abundant in the Permian and Triassic (New Red Sandstone) epochs, but in Europe appear to have almost or entirely died out by the time of the Oölite. In these early epochs they were widely distributed over the surface of the globe, their remains having been obtained from all the great continents. In size they varied from tiny creatures a few inches in length to the giants with a skull of fully a yard in length (Fig. 2). The perfect state of preservation in which the skeletons of the smaller forms occur in the fine-grained petroleum shales of the Continent shows that in their earlier stages they were furnished with external gills like modern Salamanders, thus indicating that they underwent a similar metamorphosis.

At the time that the Primeval Salamanders were so abundant, true reptiles were either totally absent (Carboniferous period) or represented by comparatively few forms (Permian), so that the *rôle* now taken by the latter was then to a great extent played by the former. We may thus consider that the place now occupied by Crocodiles was then held by the Mastodonsaur (Fig. 2), while many of the smaller forms played the part of the modern Salamanders and Lizards. Some other peculiar types developed extremely attenuated and elongated bodies, with the partial or complete loss of their limbs, and thus simulated the Blind-worms and Snakes of the present day; so that it would appear that all the places in Nature's economy now occupied by Reptiles and Amphibians, were as fully filled in those early epochs of the earth's history by these primitive creeping creatures.

That the Salamanders of the present day are directly descended from the Primeval Salamanders there can be no reasonable doubt. Indeed, if we were to take one of the Primitive Salamanders in which the skull, instead of being of the crocodile-like shape of the one shown in Fig. 2, were of the shape of a cheese-knife (parabolic), and were to make slits in the roof of this skull, to remove the sculpture from the same, and likewise to get rid of the ventral armour, and to slightly modify the structure of the back-bone, we should have a creature almost or quite indistinguishable from the existing Giant Salamander. We have already made allusion to the signs of a relationship exhibited by the Primitive Salamanders to the Crocodiles and the Fish-Lizards, but we have yet to mention indications of a kinship of far deeper interest and importance. In a previous article of the present series reference has already been made to that group of extinct Secondary Reptiles, known as Anomodonts, which are so remarkable as exhibiting unmistakable indications of affinity in respect to the structure of their bony skeleton with mammals. Now, if the reader will take the trouble to pay a visit to the gallery of extinct reptiles in the Natural History Museum at South Kensington, he will see displayed at the west end the greater part of the skeleton of an enormous creature from South Africa known as the Pariasaur. This skeleton shows that its owner occupied a kind of half-way position between the Primitive Salamanders and the Anomodont Reptiles, so that it is somewhat difficult to say to which group it should be referred, it being not even known whether it had one or two occipital condyles. This and other equally remarkable fossil types render it, however, perfectly evident that the Anomodont Reptiles have been directly derived from the group forming the subject of this article; and there is a very strong presumption that we shall eventually be able to trace the origin of mammals to creatures more or less intermediate between those two groups; the Mammalian stock having probably branched off before the two occipital condyles of the Amphibian had merged into the single one of the Reptile. We may thus look with great veneration on the Primeval Salamanders, as the probable representatives of the ancestral stock of a large portion of the higher vertebrates of the present day.

THE BOOK-LOUSE.

By E. A. BUTLER.

TO all who have the care of collections of insects or other natural history specimens, there has come, at some time or other, the vexation of seeing on the bottom of drawers or store-boxes some swiftly running, almost transparent, but exceedingly minute insects, rushing about from one specimen to another, playing hide-and-seek, as it were, under them, in a manner most provoking to their owner. They are there for no good purpose, and must be ruthlessly hunted to death, for they are the destructive creatures known as book-lice (*Atropos divinatoria*), an extremely familiar and much detested pest. Without strenuous and persistent efforts it is impossible to protect specimens, whether animal or vegetable, from their depredations; and though so minute, *Atropos* is none the less capable of causing serious damage if allowed to go on its way unchecked, as many have found to their cost, who have permitted the frequent quarantining of their collections to be intermitted for a time. Its popular name is a somewhat unfortunate one, since the suggestions of unpleasant associations which it conveys are altogether unfounded in fact. The little creature is not parasitic, and becomes a pest solely by reason of the readiness with which it will attack and devour anything that is in the least degree edible. It is a widespread and common inhabitant of houses, there being probably few from which it is entirely absent. Its minuteness, however, is an effectual means of concealment, and its presence is usually unknown and unsuspected.

The accompanying illustration (Fig. 1) will give an idea of its form, but it is so small that no details of figure

can be definitely made out in a living specimen except by aid of a lens, its length when full grown not exceeding $\frac{1}{20}$th of an inch. Hence it is hardly likely to be recognised from its portrait, except by those who are accustomed to the constant use of the hand-lens, for to the naked eye it appears as little more than a rapidly-gliding short streak, or an animated scrap of thread. It is semi-transparent, and has little colour except when mature, at which time a brownish grey, or smoky tint, is perceptible over its back. The head is remarkably large when compared with the body, and carries, amongst other organs, two long, many-jointed antennæ of wonderful thinness, finer than the most delicate of hairs, and a small pair of black eye-masses, one at each side, inclining towards the upper surface, and not at all prominent.

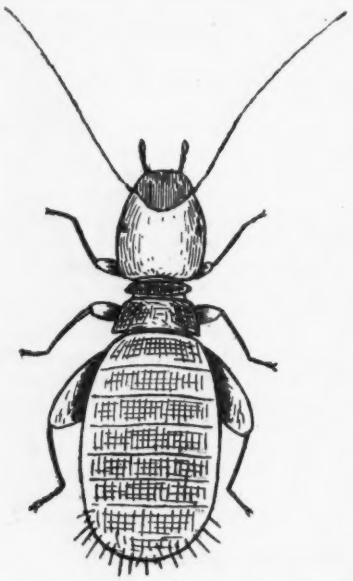


FIG. 1.—BOOK-LOUSE (*Atropos divinatoria*).

The front of the head is considerably swollen above, a feature which becomes evident only when a profile view is obtained (Fig. 2). Its extreme tip, or nose as it is sometimes called, has a ruddy tinge. A pair of palpi, which, like the antennæ, are in incessant vibration whenever the insect moves, can be seen from above projecting forwards from the front margin of the head, the real point of attachment being, however, below, on the secondary jaws or maxillæ. A strong pair of short, stout primary jaws (mandibles) constitute the only weapons of offence, and these, as having a greater thickness of chitinous covering, are darker-coloured than any other part of the body. Their shape cannot be seen without dissection, and this is no easy matter with such minute creatures; they can,

FIG. 2.—SIDE VIEW OF HEAD OF BOOK-LOUSE.

however, be easily separated from their attachments by the somewhat rough-and-ready method of crushing the delicate little being between two surfaces of glass; on running in a drop or two of water to clear away the fragments of soft tissues, they may be isolated and their outline can then be readily traced. Fig. 3 shows their form, regularly curved on the outer edge and toothed on the inner. They work across one another like the blades of a pair of scissors.

The thorax is the narrowest part of the animal; the usual three divisions are of course present, but they seem like two, as the hinder two are united into a single piece, which is, however, quite separate from and movable upon the prothorax, which in its turn forms a kind of narrow collar stretching across just behind the head. The legs are attached to the three divisions beneath, one pair to each; they are remarkable for the thickness of the thighs, which in the hind pair are extraordinarily broad, presenting an appearance such as usually indicates the possession of leaping powers; the habits of the insect, however, do not bear out this indication. The remaining part of the legs is in each case slender and almost transparent, and the feet consist of three joints only, terminated by the usual pair of claws. As with some other of our household pests, no wings are developed, though most species of the group to which it belongs have the full complement. A long, stout, but soft-skinned abdomen succeeds the thorax, a little broader behind than in front, and bluntly rounded at the end, where a few bristles project.

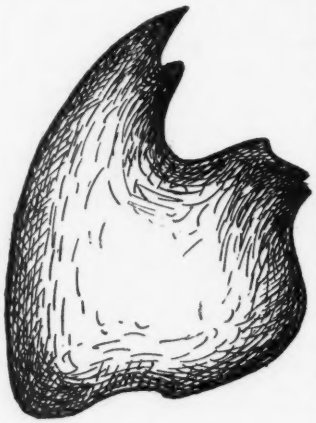


FIG. 3.—MANDIBLE (JAW) OF BOOK-LOUSE

Very little change takes place in the form of the insect during the course of its life, and it is at all times active, never losing its limbs to become a quiescent chrysalis, and belonging therefore to that section of the class Insecta in which the metamorphosis is incomplete, the division to which the cockroach and bed-bug also belong. When quite young it has but two joints to its feet, instead of three, and at the same time the number of joints in the antennæ is smaller than when fully grown.

As regards systematic position, it belongs to a family

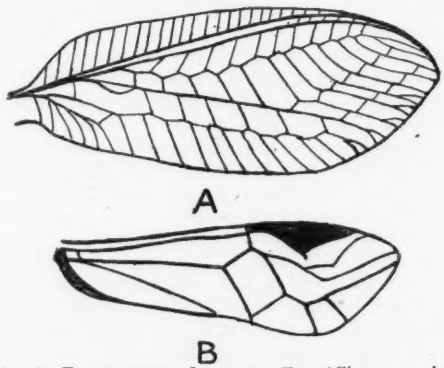


FIG. 4.—A. FORE-WING OF LACEWING-FLY (*Chrysopa vulgaris*) B. FORE-WING OF *Psocus longicornis*.

which includes several insects that are extremely abundant, but at the same time almost entirely unknown to any but professed entomologists, and hence have no popular names. The family is called *Psocidæ*, and most of our British species are pretty little winged creatures of delicate structure, in appearance something like Aphides or plant-lice. Some are found in profusion running about

over palings and fences, or on the trunks or branches of several kinds of trees, especially those of the pine and fir tribe. If the branches of a larch or Scotch fir, for example, be shaken over a sheet of paper, numbers of little creatures belonging to this family will fall out. The family *Psocidæ*, again, is reckoned as coming within the domain of the order Neuroptera (nerve-wings), an order which we have not hitherto met with in these papers on domestic pests. It is a very mixed assemblage, containing, for want of a better arrangement, in addition to the *Psocidæ*, such insects as the lace-wing flies, scorpion flies, may flies, white ants, and, according to some authors, dragon flies as well. The most uniform and characteristic feature of the majority of these insects is that the nervures of the wing are extremely numerous, dividing its surface into so large a number of minute areas that it appears to be covered with a small-meshed network, whence the name Neuroptera. The *Psocidæ*, however, are but an outlying section of this group, and do not exhibit such a minute subdivision of the wing surface, as will be seen by comparing the accompanying illustrations of the fore-wings of a lace-wing fly and a *Psocid* (Fig. 4). For this reason these insects have sometimes been spoken of as *Pseudo-Neuroptera*, *i.e.* false Neuroptera. If *Atropos* were ever found with wings, they would no doubt be of the nature of the second figure rather than of the first, but no such occurrence is known; if, on the other hand, the winged *Psocidæ* were deprived of wings, they would somewhat resemble *Atropos*, and in their earlier stages, when they are wingless, they do actually exhibit a tolerably close approximation to it. These facts are a sufficient justification for including it in the same family.

The book-louse is most abundant in summer-time, when it may be found, not only in neglected collections of animals or plants, but in cupboards, on window ledges and library shelves, and, generally, amongst old books (whence its popular name) or stores of any kind, and the more undisturbed the stores the more the insects will flourish. With their stout little jaws they sometimes do considerable damage to books, dried plants, insects, &c., nibbling away at the leaves and covers of the former, and destroying all the smaller and more easily accessible portions of the latter. Farinaceous substances seem to be peculiarly acceptable to them, and one of the most flourishing colonies that have come under the writer's notice was in a small quantity of "oat-flour," which had been left for some years in a tin canister. The little creatures had the store all to themselves, and were perfectly revelling in it.

They are very interesting little things to watch the movements of, and this is easily done by enclosing them in a glass-topped box, and examining them under a low power, say a 2-inch objective, of the compound microscope. There is a sprightliness and apparent intelligence about their actions which is quite surprising in creatures of such very minute size; and as one gazes at them down the tubes of the instrument, one cannot help thinking that if they were but a little larger they might be made pets of, and become quite companionable. One habit they have which is extremely curious. After running about for a time, they will suddenly stop, arch up the body, and raising one hind leg, bend it under the arched body and turn it round towards the mouth, pressing the foot close against the jaws; what they do with it there it is difficult to make out, but they remain in this position for some seconds, and seem to be occupied in nibbling at the foot, like a dog biting the nails of its hind-foot, and are apparently either cleaning it, or using it to clean the jaws and other parts immediately round the mouth. That a *fore*-foot should be used in this way would not be at all surprising, but it is certainly a curious acrobatic feat thus to employ a *hind*-foot.

The most interesting circumstance connected with the book-louse is the reputation it has of being a "death-watch," *i.e.* of producing a ticking sound, formerly believed to be of ominous import and to prognosticate the speedy death of some inmate of the house in which it occurs. There is a beetle, *Xestobium tessellatum* by name, which is well known for its habits of burrowing into the woodwork of old houses, tunnelling in all directions, thereby destroying the wood; this insect produces such ticking sounds, and is the true "death-watch," the tappings of which were for a long time regarded with awe and have grievously frightened many a superstitious soul; an account of this beetle will be found in a former number of KNOWLEDGE.* But the present insect, which is an altogether different creature, has also been credited with a similar habit, and there has no doubt been much confusion between the two, as both have been called "death-watch." The Rev. William Derham, of Upminster, was the first in this country to place on record statements attributing such noises to *Atropos*. He communicated two papers on the subject to the Royal Society, in which he roughly described and figured the insect and detailed his own observations. These papers may be found in the Philosophical Transactions for the years 1701 and 1704. He is careful to distinguish the insect, as regards its form and the character of its beating, from the ticking beetle above referred to, the habits and form of which had been described and illustrated in a paper presented to the same Society a short time before by Mr. Benjamin Allen, the insect being named *Scarabæus galeatus pulsator*, *i.e.* the helmeted drummer beetle. Derham gives the subject of his observations the name of *Pediculus pulsatorius* (the drumming-louse), but there can be little doubt that it was the same as that now called *Atropos divinatoria*.

He especially notices its minute size, saying that he was obliged to use a magnifying glass to watch its movements and habits. He points out, further, that whilst the death-watch *beetle* beats only seven or eight strokes at a time, and quicker, "the other will beat some hours together without intermission, and his strokes are more leisurely and like the beats of a watch." The ticking was hardly ever heard except in July and August, and was much more frequent in some seasons than in others; in the year 1702 "they ticked very much, scarce ever ceasing day or night," but the next year they were far less active, and the sound was rarely heard. The insect produced the sound by beating the front part of the head against the object on which it was resting, and Derham regarded it as in some way connected with the mating period, a sort of love-call, which would account for its being heard only at certain seasons. These two points form, indeed, the correct explanation of the ticking of the true death-watch, and so far are, therefore, possibly-operative causes in other instances as well, and are such as might readily be admitted in the present case, if it could be shown that the insect possesses the requisite mechanism. But it is just here that the difficulties come in; the extremely minute size of the insect itself, and the softness of its body, seem to be sufficient reasons to preclude the possibility of its being the author of such ticking sounds. The death-watch beetle is covered with an extremely hard integument, and is, moreover, not very minute, being about a quarter of an inch long; and it is easy to understand how blows given by its hard head against timber are sufficiently violent to be audible as repeated taps or ticks. But such

* See Vol. for 1885, p. 305.

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is by no means the case with the book-louse, and it is difficult to understand how an insect so soft as to be crushed to death by the slightest pressure, and so minute as to require a lens for the purpose of observing even its true form, can by any mechanical means at its disposal produce a sound loud enough to be audible at all, much less at a distance. It is true that the jaws are the hardest part of the body, and these, it is said, are the parts by which the noise is made; nevertheless, one would suppose that the impact of such minute specks upon any substance whatever would, except under the most favourable conditions, be quite inadequate for the production of any sound that would be audible without the aid of a microphone.

However, Derham was very positive in his statements, and since his time several other observers have recorded somewhat similar experiences, from which we may quote the following as perhaps the most circumstantial and apparently convincing. It is a record by Mr. J. Blackwall in the *Entomologists' Monthly Magazine* for 1867:—"A ticking sound, so precisely similar to that of a watch as scarcely to be distinguished from it by the nicest discrimination, was perceived to proceed from a small work-box, comprising several compartments. Now, as this very remarkable noise, which differs widely from the tapping sound produced by *Anobium tessellatum*, is supposed by many persons to be caused by some species of spider, I resolved to investigate the phenomenon; accordingly, having placed the work-box on several sheets of writing paper, I proceeded to open the compartments in succession, examining each, with its contents, in a good light, assisted by the employment of a large lens. After having carefully inspected the compartment first opened, a pause ensued, till the sound, which had been interrupted, was renewed. Proceeding cautiously in the manner described, the ticking sound was ultimately traced to the last compartment, which served the purpose of a pin-cushion, and was filled with bran. On the cover being withdrawn, the bran was removed in very minute quantities to a sheet of writing paper, each portion, when lightly spread by means of a feather, being closely examined under the lens. The only occupant of the box detected by this complete scrutiny was a living *Atropos pulsatoria*; and I think the facts of the case fairly warrant the deduction that the ticking sound was produced by it, more especially as no such sound was ever after heard to emanate from the box. I may add that the *Atropos*, which was placed in a clean phial, died in the course of an hour, without emitting any perceptible sound."

The insect called *A. pulsatoria* in the above extract is the same as what is now known as *A. divinatoria*, and the evidence is obviously so strong in its favour, that it is only the very great mechanical and acoustical difficulties involved that cause one to hesitate about accepting it. To those, moreover, who have known these insects for many years, and have more or less continuously had them under observation, and yet have never heard the slightest sound proceed from them, it may perhaps be allowed to be still somewhat sceptical.

Another kindred insect sometimes accompanies *Atropos* in its burglarious visits to insect collections. It is a rather larger creature, with more prominent eyes, and with roundish scales in lieu of wings. It is called *Clothilla pulsatoria*. Another, still larger, of a blackish colour, may also very occasionally be found in extremely neglected collections, especially of foreign insects. It is known as *Clothilla* or *Lepinotus picea*. There is a family likeness about these insects that is unmistakable, and renders them easily recognised, and they can scarcely be confounded with the larger, more rotund, and slower eight-legged mite, which is even a worse enemy to collections of dried insects.

INSECTIVOROUS PLANTS.

By J. PENTLAND SMITH, M.A., B.Sc., *Lecturer on Botany, &c., Horticultural College, Swanley.*

(*Continued from page* 269.)

THE Nepenthes or Pitcher Plants are confined in their geographical distribution to the tropical regions of the globe—tropical Australia and tropical Asia, the Seychelles, New Caledonia, and the Malayan Archipelago. They are all moisture-loving plants, and are almost epiphytic* in character, like foreign orchids. To compensate them for their inability to obtain a large supply of nitrogen in the ordinary way, the leaves have undergone a metamorphosis at once curious and striking.

The main vein or "mid-rib" of each leaf is developed into a long thread-like tendril, which, after the manner of ordinary tendrils, twines round neighbouring objects, and so forms a means of support. In the young state a globular swelling is noticeable on the apex of the tendril. As the leaf increases in age the swelling increases in size, until, when the leaf has reached maturity, it develops

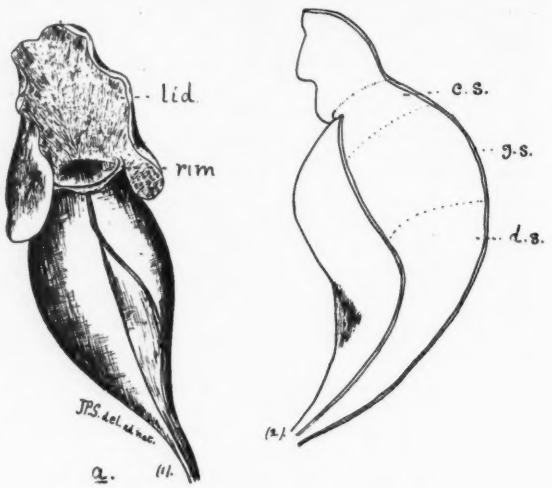

FIG. 1.—a (1) Leaf of *Sarracenia purpurea* (about natural size); (2) the same in longitudinal section; *c.s.*, conducting surface; *g.s.*, glandular surface; *d.s.*, digestive surface.

into the pitcher or urn which gives the characteristic appearance to these familiar green-house plants (Fig. 2, c). At the apices of the leaves of many plants there are water-pores, somewhat similar to the so-called breathing organs described in KNOWLEDGE, November 1890, differing from them in their inability to open or close. These pores are in connection with water-secreting glands, and, according to Sir Joseph Hooker, each pitcher of Nepenthes is, by development and position, the equivalent of such a gland.

Running down the outside of the pitcher are two wings. Crowning the pitcher is a lid or cap, fastened at one part to the rim of the urn. In the young state the lid is firmly closed over the orifice of the pitcher. During development it is gradually uplifted until it takes up the position represented in Fig. 1, c. The pitchers vary very much in

* An epiphyte is a plant whose roots do not penetrate the soil, but are freely exposed to the air, and absorb therefrom nitrogenous and other materials.

size. That represented in the figure is about the natural size, but some are much smaller, others very much larger.

What means does the pitcher-plant employ to lure insects into its deadly grip? On the under-surface of the *blade* of the leaf, and on the outer surface of the pitcher and lid are glands which secrete honey (Fig. 4, d, *h.g.*). Insects, and especially ants, are attracted by the sweet material, and, guided by the wings, they at length reach the rim of the pitcher. On the under-surface of the lid there are also honey-glands. All these glands are sunk deep into the tissues, and partially covered all the way round by the surrounding skin or epidermis. They are

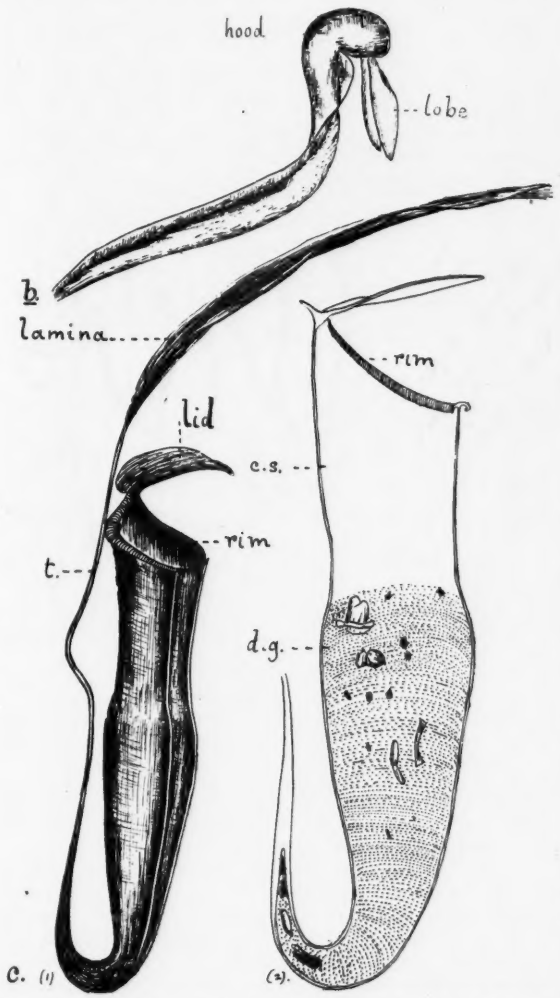

FIG. 2.—b. Leaf of *Darlingtonia Californica*. c. Leaf of *Nepenthes Mastersiana*; *t*, tendril; *c.s.*, conducting surface; *d.g.*, digestive surface.

attracted into the cavity of the pitcher by a honey-like material secreted by bottle-shaped glands (Fig. 4, e), whose openings, visible to the naked eye, line the inner margin of the corrugated rim. This rim is for these reasons a deadly trap to insects. The corrugations are prolonged in the inside into teeth more or less sharp, and sometimes so large as to prevent the escape of a humming-bird which has trustfully come to sip the nectar. As it is folded in over the inner surface of the pitcher, it effectually prevents the escape of any insect which has once passed its barrier; and, in the third place (which ought to have been put first), it attracts the insect to its doom by the honey-secretion of its glands. The upper surface is covered with a very fine smooth layer of cells, which with their waxy coating afford no foothold to any animal which has landed on it. Here there are ledges which are the representatives of altered stomata (Fig. 2, c, and Fig. 4, f). The remainder of the pitcher is studded with glands which secrete a digestive fluid (Fig. 2, c, and Fig. 4, g, *d.g.*). They are exceedingly numerous; it has been calculated that there are as many as 3,000 on a square inch. If one examines the pitcher even before it opens, he will find it to be about half-filled with a watery fluid. That is present at all times, and digests any animals which find their way into the cavity of the pitcher. The origin of the fluid is the numerous glands of which we have spoken.

The upper surface of the pitcher is the conducting surface. It conducts insects or other animals to the lower or "digestive" surface. It is not until the glands have been irritated that the secretion has the power of digestion. Although it has previously a slightly acid reaction, yet enough acid is not present to effect the digestion of proteid material. The glands are, like those previously mentioned, developed from the epidermis. In section each one appears as a single cell, on which rests a mass of cells, the whole presenting the appearance of a globular wart. On surface-view they are seen to be half covered by a down-growing semi-transparent flap of the epidermis (Fig. 4, *g*). They form a most beautiful microscopical object, and are easily prepared.* In Fig. 1, c, are seen the remains of a cock-roach which has been partly digested by the plant. All the parts of the insect have been absorbed excepting the horny covering of its body. In the pitcher figured was found a *Julus*, about one inch long, which would shortly have been unable to resist the action of the digestive fluid.

Sarracenia is generally held to belong to a group of plants which does not digest its prey, but, first allowing decay to set in, absorbs the products of decomposition. All the species are marsh-loving plants, and are found only in the Eastern States of North America. "[The flower] has a singular aspect, due, to a great extent, to the umbrella-like expansion in which the style terminates. The shape of this, or perhaps of the whole flower, caused the first English settlers to give the plant the name of Side-Saddle Flower."†

All the leaves of this plant, like those of Nepenthes, are developed into pitchers, which, however, in point of origin, cannot be considered equivalent to Nepenthes, as in this case the whole of the leaf has become modified into a pitcher. Each pitcher is furnished with a lid, whose under (inner) surface is covered with down-growing hairs—prolongations of the cells of the epidermis. Interspersed amongst these are glands which secrete honey (Fig. 1, a, and Fig. 3, a, *h.g.*). Stomata are also to be found here. This has been termed by Hooker the *attractive* surface, from the presence of the honey glands, whose secretion, like that of the kindred glands in Nepenthes, has a fascination for members of the insect tribe. It is often more highly coloured than the rest of the pitcher, to subserve the same function. Honey glands are also present around the mouth of the pitcher. The upper portion of the urn represents the *conducting* surface.

* Boil a portion of the pitcher in a test-tube in some strong caustic potash. After boiling for ten minutes the epidermis will easily peel off, and can then be mounted as previously mentioned (KNOWLEDGE, November 1890).

† Address to the British Association, Belfast, 1874, by Sir J. Hooker.

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It is opaque and clothed with glossy cells, which are produced into conical downward-directed hairs (Fig. 3, b). These projections form, like the tiles of a roof, a surface along which the insect easily glides downwards, and which offers no support to its feet when it seeks to creep on it. The lower part of the pitcher Hooker named the *detentive* surface. It generally occupies the greater portion of the cavity of the pitcher, and is covered with stiff needle-shaped hairs, directed downwards (Fig. 3, c). Every epidermal cell of the conducting surface is produced into a hair. Only a few of those of the detentive surface are so prolonged. The hairs in the latter case are very much longer than in the former. Their rigidity and position in the pitcher effectually prevent the exit of any insect when once it has been lodged amongst them. Its endeavours to escape only serve the purpose of fixing it more firmly in its enemy's toils. The hairs then act like fish-hooks; the more the insect seeks to part company with them, the closer they cling.

It is said by Mellichamp that the honey secreted at the mouth of the pitcher at certain periods trickles down the outside, and forms two guiding lines for the benefit of exploring insects. They are thus led to the mouth of the structure, and once having attained that position their destruction may be considered sure. They seek the honey distilled from the nectar glands on the under surface of the lid, and, lured by similar hopes of a feast to the inner part of the pitcher, they thus reach the conducting surface. Once there, all hope is abandoned; unable to obtain a footing, they are precipitated into the depths of their enemy's den.

A liquid is found in the pitcher, but whether it is secreted or not by the pitcher, and at what periods, is not certain; and its nature is not understood. It does not, however, have a digestive action like that of the Pitcher-plant, and, moreover, the accumulation of dead and decomposing insects renders the cavity of the pitcher an unpleasant companion on very close acquaintance; thus differing materially from Nepenthes, in which the decomposed matter is disinfected by the peptic fluid.

Hooker affirmed that the epidermis of the detentive surface was destitute of a cuticle (the cuticle is the continuous outer covering of the skin of the plant; it is generally more or less impervious to water). Since his time Batalin, in an article "On the Function of the Epidermis in the Pitchers of Sarracenia and Darlingtonia," in *Acta Horti Petropolitani*, tomus vii., has shown that this statement is inaccurate. His observations differ materially from those of Hooker. The latter supposed that the insects, which are to be found in great numbers in the pitcher, supply the plant with nitrogen only indirectly. After the death of the leaf they serve as manure for the soil, which is poor in nitrogen. Batalin, on the contrary, has shown that decomposition of the insect goes on inside the pitcher; that at the point where it adheres to the cell-wall the cuticle undergoes dissolution; the products of decomposition are absorbed directly by the leaf, and the dissolution of the cuticle facilitates this process. "Dissolution of the cuticle is caused by the adhering of the insect to the epidermis; direct observation shows that only those cells have thrown off their cuticle on which the dead bodies of insects have adhered," and they can thus be easily distinguished from the neighbouring cells in which this process has not taken place.

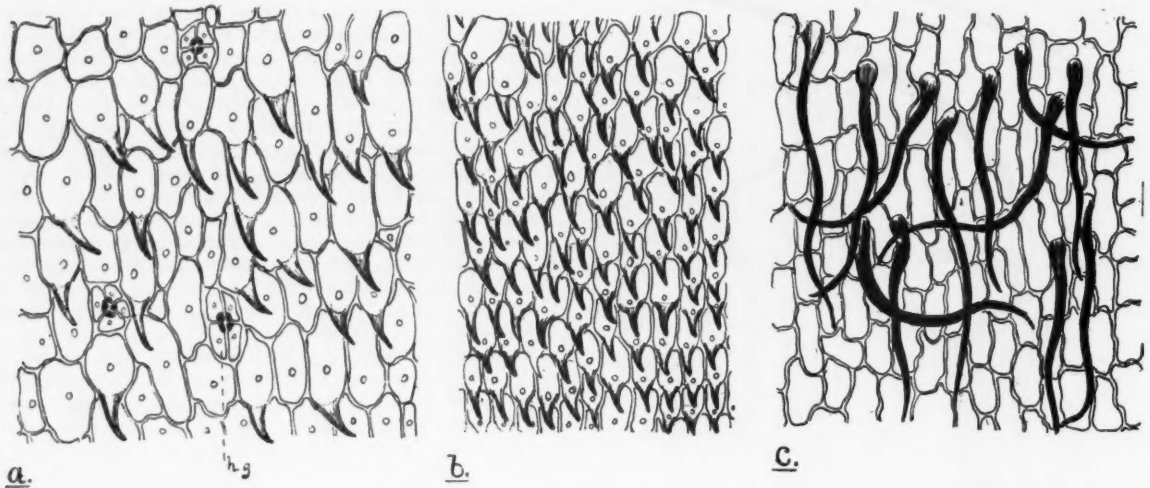

FIG. 3.—a. Epidermis from under surface of lid of *Sarracenia flava*: *h.g.*, honey-gland. b. Epidermis from *conducting* surface of same. Every cell is produced into a downward-directed hair. c. Epidermis from lower portion of pitcher (*detentive* surface) of same. Very long hairs are developed from certain of the cells.

It is a curious fact that many insects deposit their eggs on the mass of insects in the pitcher, in order that the larvæ may be fed on the semi-decomposed contents.

Sarracenia purpurea, which is figured in the accompanying sketch, has a slightly different structure from that already given, which is the structure found in all other species. No honey secretion is found in the pitchers, and the lid is so placed that the pitcher may obtain as much rain as possible. It has a special glandular surface, which is perfectly smooth (Fig. 1, a, *g.s.*).

The lid in all cases is as firmly fixed as that of the Pitcher-plant, yet it was affirmed by an old writer to be possessed of a hinge. Succeeding writers enlarged upon this statement, declaring that the lid closed over the mouth of the pitcher in dry weather to prevent the contained water from evaporating. Still more curious is the idea put forward by another observer, that "they might serve as an asylum or secure retreat for numerous insects from frogs and other animals which feed on them; and others followed Linnæus in regarding the pitchers as reservoirs for birds and other animals, more especially in times of drought."

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Allied to the foregoing is *Darlingtonia Californica*, which is found at a height of 5,000 feet in California. All the leaves develop into pitchers, one of which is represented in Fig. 2, b. The mature pitcher has a hood; depending on each side of it are two lobes, which are covered on the inside with honey-like material. The construction of the inside of the pitcher is much the same as that of Sarracenia and its action upon insects is probably the same.

Utricularia, or bladder wort, found in our streams, is also a non-digesting insectivorous plant. Bladders furnished with a valve appear on its stems, and in the interior are

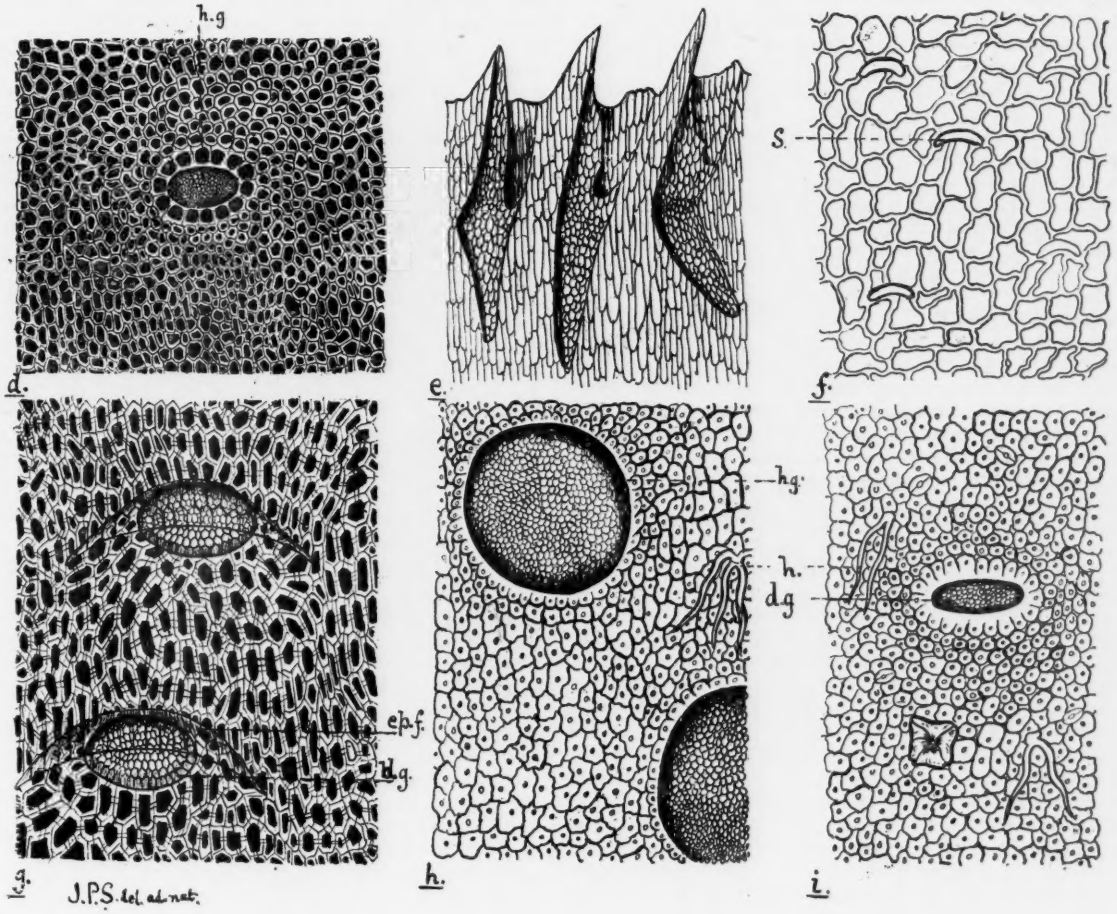

FIG. 4.—d. Epidermis from under surface of the lamina (blade) of *Nepenthes hybrida*; *h.g.*, honey-gland, partially covered by epidermal cells. e. Epidermis from inner margin of rim of pitcher of above. The pockets are honey-glands. f. Epidermis from conducting surface of *Nepenthes Mastersiana*. Note the smooth surface, and altered stomata (*s*). g. *Nepenthes hybrida*. Epidermis from *digestive* surface; *ep.f.*, epidermal flap; *d.g.*, digestive gland. h. *Nepenthes Mastersiana*. Epidermis from outer surface of pitcher; *h.g.*, honey-gland; *h*, hair with many processes. i. Epidermis from upper surface of the lid of above *d.g.*, honey-gland; *h*, hair.

often found minute Crustaceans, which, having once entered the bladder, find it impossible to escape owing to the construction of the valve.

We stated previously that the digestive action exhibited by *Drosera*, *Pinguicula*, &c., was due to a ferment. The ferment active in these cases belongs to the *unorganised* group of ferments. The other group is the *organised*. Of the former, the diastatic and peptic are the most important. The diastatic receive their name from diastase, the chief member of the division, which is found in the germinating seeds of grasses, such as barley, and it is probably present with that of the plants in which they are so evidently present. They are also found in seeds containing albumen, which substance they render soluble, so that it may, like the starch, be in a state capable of being absorbed by the embryo plant. It is probable that peptic ferments are present in the majority of cells of all plants.

Organised ferments are familiar to us in the Yeast plant, which changes sugar into alcohol. Unless continuously supplied with sugar and nitrogenous material, the alcohol so produced will soon kill it.

"Unorganised ferments, such as diastase and pepsin,

in all seeds which contain material stored up for the nourishment of the young plant. When the seed is moistened the young plant commences to develop, and at the same time the albuminous reserve material produces the ferment diastase which converts the stored-up starch into sugar. Starch is insoluble in the cell-sap, and so cannot penetrate the membrane of the cells; sugar is soluble, so the embryo, or young plant, can directly benefit by its presence.

Peptic ferments cannot act unless in the presence of an acid. Their action has already been detailed in connection

convert food materials into forms by which they may be readily absorbed by the organism. An organised ferment has just the opposite character: its products are, without exception, less nutritious compounds, and it destroys especially the most nutritious substances."*

Notices of Books.

Are the Effects of Use and Disuse inherited? By WILLIAM PLATT BALL. (Macmillan & Co.) If an organism, by the excessive use of any one of its organs, produces an increased development of that organ, or if, by a persistent disuse, it causes a gradual atrophy of the part, will such increased or lessened development be for that reason inherited by its posterity? Such, in brief, is the question Mr. Ball discusses, criticising in doing so the views held by Spencer and Darwin. At first sight it seems natural enough to reply in the affirmative to the question proposed; the mind readily recurs to such instances as the loss of eye-sight amongst animals that inhabit caves, the reduction in size of the wings of cursorial birds, and the presence of rudimentary organs generally, all of which seem to be instances in point. But, while the facts are, of course, not disputed, the explanation, the author thinks, will not hold good. To avoid circumlocution, he uses the term "use-inheritance" to express the direct inheritance in offspring of modifications caused in their parents by the habitual use or disuse of parts, and the position he takes up, and indeed defends with considerable ability, is that use-inheritance is at best but a shadowy factor in the process of evolution, and that probably it is usually so ineffectual as to be practically altogether inoperative. He maintains that natural selection alone, the force whereby "the weakest goes to the wall," and "the battle is to the strongest," is sufficient to account for the perpetuation of modifications such as those referred to, without calling in the aid of any such factor as use-inheritance, which, indeed, if admitted, is shown to have produced in some cases apparently contradictory results. That the effects of use or disuse of certain organs appear in the modification of the organism's posterity is admitted, but it is denied that such effects have been transmitted *because* they resulted from use or disuse, the author's contention being that they are perpetuated because thereby the organism is better fitted to its surroundings, rather than because of any process of use-inheritance simply as such. The distinction is perhaps a somewhat fine one, but nevertheless perfectly valid, and, as the author points out, may have, if maintained, and pressed to its ultimate issue, an important bearing on sociological and moral problems. Perhaps the following quotation best illustrates Mr. Ball's position: "'Use' is at bottom the determining circumstance in evolution generally. The trunk of the elephant, the fin of the fish, the wing of the bird, the cunning hand of of man and his complicated brain . . . can only have been moulded and developed by use—by usefulness and by using—but not necessarily by use-inheritance, not necessarily by directly inherited effects of use or disuse of parts in the individual. So, too, reduced or rudimentary organs are due to disuse, but it by no means follows that the diminution is caused by any direct tendency to the inheritance of the effects of disuse in the individual. The effects of natural selection are commonly expressible as effects of use and disuse, just as adaptation in nature is expressible in the language of teleology. But use-inheritance is no more proven by one of these necessary coincidences than special design is by the other. The inevitable simulation of use-inheritance may be entirely deceptive." The author labours under the proverbial disadvantage of having to prove a negative, which, indeed, he candidly admits; but, nevertheless, his argument is in general weighty and deserving of thoughtful consideration. In endeavouring, however, to show that use-inheritance would sometimes be an evil, he seems to confuse two different ideas. According to his own definition, the term "use-inheritance" signifies "the direct inheritance of the *effects* of use and disuse in kind"; but in the following passage it seems to be employed in a somewhat different sense: "Use-inheritance would crudely and indiscriminately proportion parts to actual work done. . . . Thus the condyle of the human jaw would become larger than the body of the jaw, because, as the fulcrum of the lever, it receives more pressure. Some organs (like the heart, which is always at work) would become inconveniently or unnecessarily large. Other absolutely indispensable organs, which are comparatively passive, or are very seldom used, would dwindle until their weakness caused the ruin of the individual, or the extinction of the species." As such effects have not been observed to be produced by the continued use or disuse of the parts, there seems to be nothing for use-inheritance, as defined by the author, to perpetuate, and the objections seem, therefore, rather beside the mark. Moreover, in reference to one of the instances, it surely does not follow that, in the case of such a lever as the human jaw, the condyle receives *more pressure* than the body of the jaw.—E. A. B.

Home Life on an Ostrich Farm. By ANNIE MARTIN. (George Philip & Son.) The authoress of this book is an intelligent, cultured, and well-travelled wife of the ostrich farmer; she is, moreover, an enthusiastic admirer of nature, and of refined taste, yet entering thoroughly into the "dear, delightful, rough African life," notwithstanding all its drawbacks. In working a "farm" 12,000 acres in extent, in a South African district, abundant opportunities would evidently be afforded for the exercise of such capacities, and our authoress has availed herself of them to the utmost. By taking her subject in its widest sense she has accordingly given a most readable description of the physical features, climate, inhabitants, manner of life, and most remarkable animals and plants of that portion of Cape Colony called the "Karroo," where the ostrich farm was situated. The district is described as most health-giving, its dryness making it peculiarly suitable for consumptive patients, and invalids are spoken of who, having gone out in advanced stages of the disease, have been rapidly retored to health and vigour. The fearful droughts and hot winds, however, which are both prevalent and prolonged, would, we suspect, constitute serious drawbacks in the eyes of those who could not, as our authoress could, sit out of doors in the full blaze of sunshine, and "*revel* in a bath of hot, dry air." The book is written in an interesting, chatty style, pleasantly flavoured with much humour, and is illustrated with ten engravings, some of which seem to be reproductions from photographs of ostrich farms. Copious details of ostrich farming are given, together with many amusing anecdotes of these curious birds, and of several favourite animals kept as pets. From many of these we would gladly have quoted did space permit; the following extracts must, however, suffice. Concerning the "nest" eggs, Mrs. Martin says: "The hen ostrich lays every alternate day;

* Sach's *Physiology of Plants.*

and if, for each egg laid, one is taken from the nest, she will continue laying until she has produced from twenty to thirty. . . . If no eggs are taken away, the hen leaves off laying as soon as she has from fifteen to twenty; the latter being the greatest number that can be satisfactorily covered by the birds. . . . Every morning and evening the nest, or rather the shallow indentation in the sandy ground which forms this simplest of all 'homes without hands,' is left uncovered for a quarter of an hour to allow the eggs to cool. The sight of nests thus apparently deserted has probably given rise to the erroneous idea that the ostrich leaves her eggs to hatch in the sun." One of the dangers to which the eggs are exposed is thus described: the hen having left the nest to obtain her meal for the day, "now comes the white-necked crow's chance, for which, ever since at earliest dawn he drew out his artful old head from under his wing, he has been patiently waiting. An ostrich-egg is to him the daintiest of all delicacies; but, nature not having bestowed on him a bill strong enough to break its hard shell, he is only able, by means of an ingenious device, to enjoy its contents. He carefully watches till the parent's back is turned and she is a good distance from the nest; then, flying up into the air, he drops a stone from a great height with a most accurate aim, and breaks an egg. He makes good use of his quarter of an hour; and he, no less than the hen ostrich, has had an ample meal by the time the latter returns to the nest." The duties of incubation the pair of birds share as follows: "A few of our birds were fenced off in breeding-camps, each pair having a run of about one hundred acres. One of these camps was directly opposite the house, and from the windows we could observe the regularity with which the two birds, sitting alternately on the eggs, came on and off at their fixed times. The cock always takes his place upon the nest at sundown, and sits through the night—his dark plumage making him much less conspicuous than the light-coloured hen; with his superior strength and courage, too, he is a better defender of the nest against midnight marauders. At nine in the morning, with unfailing punctuality, the hen comes to relieve him, and take up her position for the day. At the end of the six weeks of sitting, both birds, faithfully as the task has been shared between them, are in a very enfeebled state, and miserably poor and thin." But we must refer our readers to the book itself for further details, and for a most entertaining picture of colonial life.

Applied Geography: a Preliminary Sketch. With eleven maps and diagrams. By J. SCOTT KELTIE, Librarian to the Royal Geographical Society. (London: Geo. Philip and Son, 1890.) This is a small book on a great subject, by a very competent writer. Its object is to show the bearings of geographical knowledge on human interests generally, but with prominent reference to their industrial and commercial sides. The first chapter is an excellent summary, with illustrations from Buckle, Green, and other writers, of the interrelation of races and their surroundings, and the consequent shaping of the destinies of the one by the character of the other. The subject should have paramount interest for us, as the world's great colonisers; and a study of this thoughtful book cannot fail in awakening the reader to the shameful neglect of geographical knowledge in our current systems of education. Mr. Keltie refers to the sanitary advantages resulting from planting the Australian *Eucalyptus* in unhealthy places. We speak with diffidence, but under an impression that this has been disputed.

The Development of Africa. By ARTHUR SILVA WHITE. (London: Geo. Philip & Son, 1890.) Mr. White, who is the secretary of the Scottish Geographical Society, has done a seasonable and serviceable piece of work in collecting from manifold sources a mass of information about Africa, and putting it into compendious and well-ordered form. His book appeals to a large and varied class, since it deals not only with the physical features and the indigenous races of the Continent but with those social, industrial, and religious questions which acquire fresh interest under the recent adjustment of their several boundaries and "spheres of influence" by the European Powers. The romance, with all its pathos and mystery, which has so long invested the great island-continent is gone, and to this succeeds the prosaic but most difficult task of developing the manifold resources of Africa by more merciful methods than those of the slave-trader and the gin-seller. Mr. White has some excellent remarks on this matter, which may, we hope, tend to the effacement of the international jealousies whose play gives the ivory-hunter and the spirit-seller—those twin demons—fresh lease of life. And he also shows very forcibly how Mohammedanism, maintaining a united front, preaching a simple doctrine, and adapting its moral code to the self-indulgent life which a tropical climate fosters, has succeeded where Christianity, with its divided sects and more rigid moral attitude, has failed. The book, which is to be commended for its clear and vigorous English, is enriched with fourteen maps illustrating the several chapters, the merits of which are implied in the fact that they are drawn by Mr. Ravenstein.

THE SUN'S PHOTOSPHERE.

By A. C. RANYARD.

THE visible surface of the sun, which we see under ordinary daylight conditions with the naked eye or with a telescope, is called the *photosphere*. When the sun is totally eclipsed faint rays and curving structures are seen towering upwards to a height of sometimes more than a solar diameter above the brilliant sphere, which is then hidden.

It is evident, therefore, that what we ordinarily call the sun is only the bright spherical nucleus of a nebulous body. The tall, curving rays and faint nebulous structures are usually spoken of collectively as the corona, and the bright region at its base just outside the photosphere, which, as seen during a total eclipse, generally appears red, is called the chromosphere. Here and there tree-like structures, or "prominences," shining principally with monochromatic light, tower to a few tens of thousands of miles above the photosphere. The forms of these prominences, as well as the curious curving and tree-like forms of the corona, show that there is a frequent interchange of matter between the region inside the photosphere and the regions outside the photosphere occupied by the chromosphere and corona. The prominence forms of the chromosphere may be watched under ordinary daylight conditions with the spectroscope, and may be frequently seen rising and spreading, and then fading away after the lapse of a few hours. It is clear, therefore, that the matter of which the corona and chromosphere is composed must be similar to the matter within the body of the sun—though it may be under different conditions of pressure and temperature. The great velocity with which the prominence matter issues from the sun, and the vast bodies of gas (many millions of cubic miles even in the smaller prominences) which come up at the same time, preclude the idea that a portion of the gaseous constituents are precipitated and left at the level of the photo-

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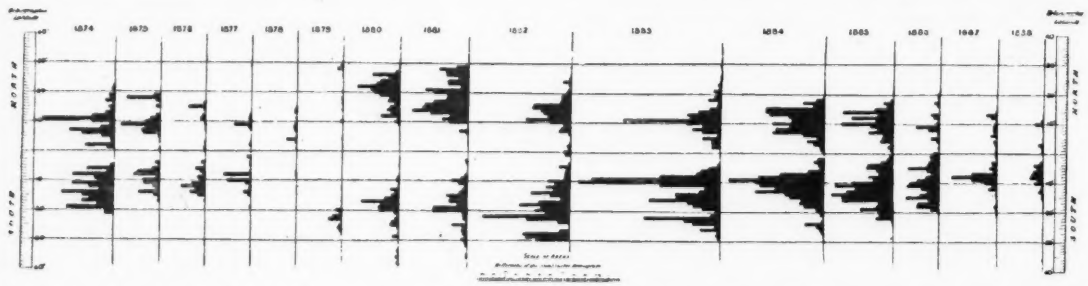
sphere. Though in the case of more slowly rising matter such a precipitation at a level corresponding to a certain temperature seems to be not only possible but probable; and in regions where the precipitated matter is not carried still further upwards, it will glow at a temperature closely corresponding to the highest temperature which the precipitated particles can endure in the liquid or solid form without being driven into vapour. On the other hand, in regions where the rush of gas carries the precipitated matter farther upwards, it will cool down; and though possibly it will remain incandescent in the liquid, and subsequently in the solid form, when at a much greater altitude, yet it seems probable that it will shine with a light which is faint compared with that with which it shone when first precipitated.

In view of these considerations, it becomes a question of great interest to determine what is the probable temperature of the matter of the solar corona. Some approximation towards an estimate of the temperature of bodies situated within a solar radius of the photosphere may be derived from experiments with burning glasses. If we neglect the considerable loss of heat, which must be caused by the absorption of the glass of the lens or lenses used, the temperature in the focus of a burning-glass will be approximately the same as that of a particle of matter at a distance from the sun where the solar disc would appear as large as the condensing lens viewed from its own focus. Platinum may be melted like wax in the focus of a burning lens which subtends less than eighty degrees at its focus. Consequently, a mass of platinum, and all the meteoric irons and stones with which we are acquainted, would be melted at a distance a little less than a solar radius from the surface of the photosphere; and we may feel certain that the light of the corona, and much more the light of the sun itself, is not due to the clashing of solid bodies, such as meteorites.

As regards an upper limit for the temperature of the corona, two classes of observations made during total solar eclipses indicate that the corona is not purely gaseous, but that it contains particles capable of dispersing the sun's light. Both classes of observations may be satisfied by the existence of very minute liquid particles in the corona, the average diameter of which is small compared with the wave lengths of visible light.*

These considerations would lead us to conclude that the photosphere is a shell of intensely incandescent clouds condensed from the vapour around and below them. We cannot correctly speak of the photospheric clouds as floating in an atmosphere; for there can be no analogy between the condition of the vapour at the level of the photosphere and an atmosphere like the earth's atmosphere, in which one layer rests on the layer immediately below it. On the earth the density of our atmosphere is halved with every ascent of about $3\frac{1}{2}$ miles, and on the sun, with gravity in the region of the photosphere more than $27\frac{1}{2}$ times as great as terrestrial gravity, we should have, neglecting variations of temperature, a doubling of the density with every increase of depth of an eighth of a mile. This is a law which follows from the condition that the upper layers are supported by the elasticity of the layers below them; and we should have the density of the gaseous atmosphere quadrupled with every descent of a quarter of a mile, and with a descent of 10 miles the density of such a solar atmosphere would increase in the proportion of 1 to 2 raised to the power of eighty. In other words, if the density of the solar atmosphere at any level were only one-millionth of the density of the terrestrial atmosphere at the sea-level, the density of the solar atmosphere at a depth only ten miles below would, if gaseous compression could be continued so far, exceed the density of platinum; which is an utterly preposterous supposition, especially when we remember that the density of the whole sun is only about one-quarter of the density of our earth. We must therefore conclude that the major part of the region within the photosphere is occupied by vapour in which the molecules are not moving as the molecules in our atmosphere, first in one direction and then in another, with a rapid series of collisions and alterations of direction, so as to constitute a gas capable of exercising an equal pressure in all directions. We can easily conceive how particles may be held in suspension in such a gaseous region by continuous bombardment from below,† added to the repulsion produced by their own evaporation towards a hot body or a hot gaseous centre; each molecule of vapour evaporated from them towards the hot centre giving the particle a kick backwards in a direction contrary to the action of gravity.



An examination of the plates which have been made from two beautiful photographs kindly given me by Dr. Janssen for reproduction in KNOWLEDGE will show that the surface of the sun is apparently covered by a curious mottling which is well worthy of close examination.

A magnifying-glass of low power should be used to bring out all that can be seen upon the plates. There is, as it were, a reticulation of clearly defined areas extending over the whole of the photosphere. The meshes, or inter-

* The polarization of the corona corresponds to the polarization which would be produced by the dispersion of the sun's light by fine dust floating in the coronal region. The polarization colours seen on the corona with a suitable polariscope extend down to the moon's limb, and it seems probable, from considerations which I have published elsewhere, that the polarization is caused in the lower regions of the corona as well as in the higher regions through which the line of sight passes on this side as well as on the farther side of the solar limb. The fact that the solar absorption lines have been observed in the continuous spectrum of the coronal light also points to the conclusion that the sun's light is dispersed by matter other than gaseous matter in the coronal region.

† That immense vertical movements below the photosphere are constantly going on is also rendered highly probable by the different rotation periods of the gaseous mass deduced from spots in various heliographic latitudes.

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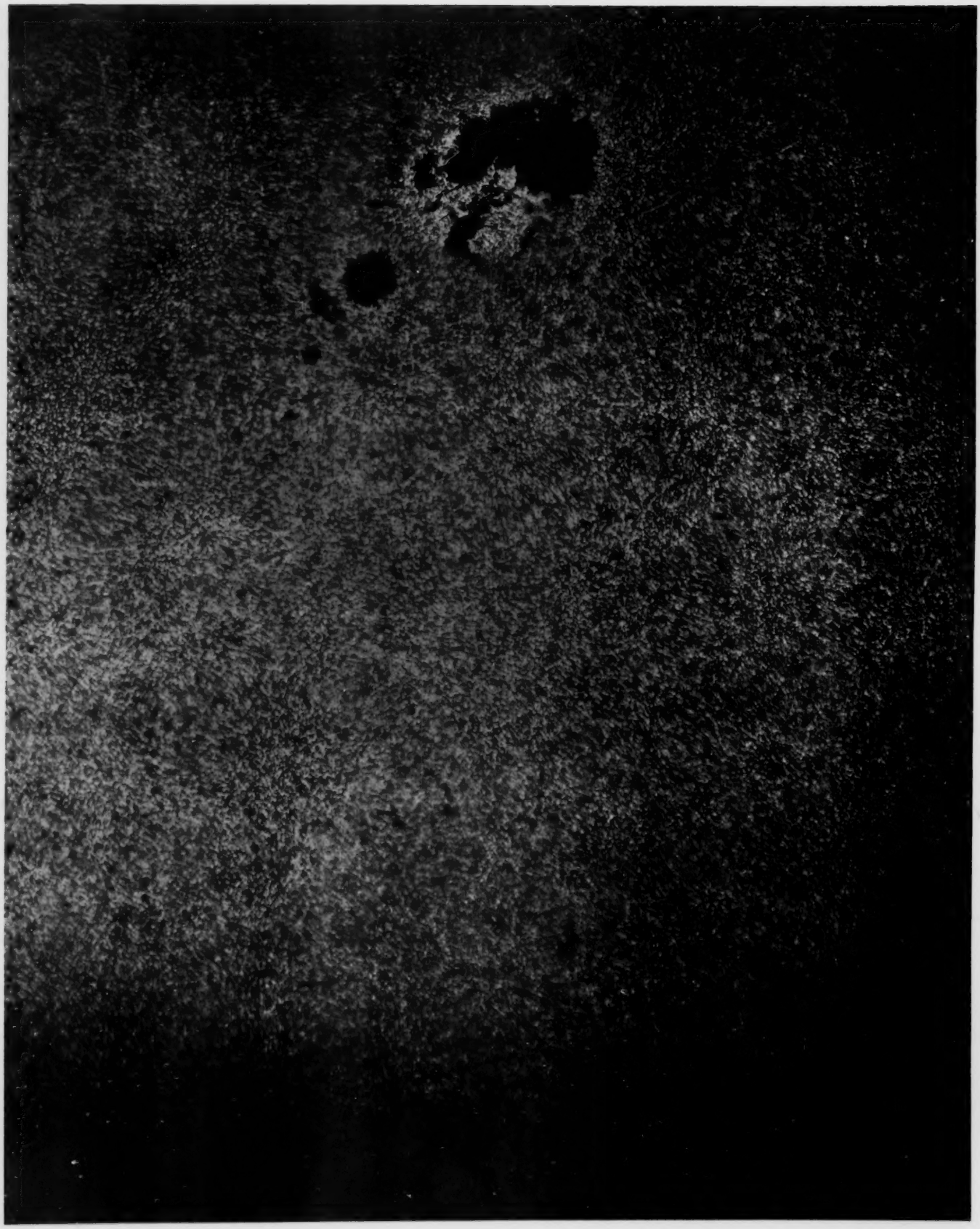

I. Photograph of the Sun's Surface, showing Group of Sun-spots and Rice-grain Structure of Photosphere of Sun-spot, maximum type.

Taken at Meudon on the 1st of June, 1881, by Dr. JULES JANSSEN, with an Object-glass of five French inches aperture, two metres, 10 cent. focus, and an Eye-piece enlarging the Image in the principal Focus, fifteen diameters. Diameter of the Sun's Image, if on the same scale as in plate, three-quarters of a metre.

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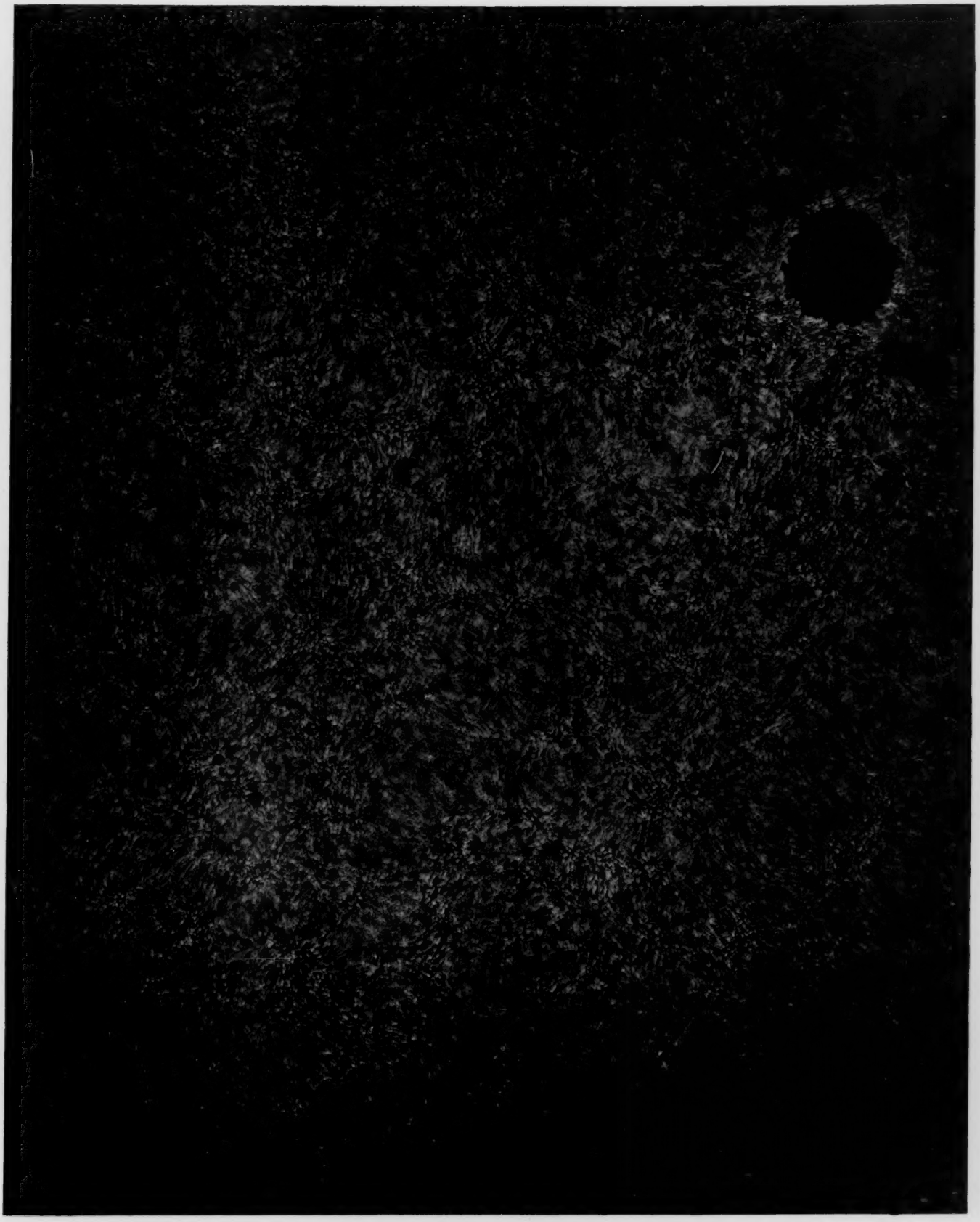

II. **Photograph of the Sun's Surface, showing Symmetrical Sun-spots and Willow-leaf Structure of Photosphere of Sun-spot, minimum type.**

Taken at Meudon on the 10th of June, 1887, with Refractor of five inches aperture. Diameter of the Sun's Image, if on the same scale as in plate, three-quarters of a metre.

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spaces, of the great network are occupied by smudged or hazy areas where the brilliant clouds and dark interspaces are not so clearly defined. Along the lines of the network the brilliant cloudlets seem to be turned so as to lie parallel to one another, as if they had been raked or combed, and a number of clearly defined minute dark spaces or spots are visible between them. These smudged areas are not caused by any photographic defect, as is proved by their persistence on photographs taken with an interval of a few minutes, though they change from hour to hour. During a recent visit to Meudon (Dr. Janssen's Observatory near Paris) he showed me several photographs indicating that there is a change in the general character of the granulation of the photosphere or rather of the forms of the cloudlets, which corresponds with the sunspot maximum and sunspot minimum periods.

The change is very well illustrated by the two photographs he has given me for the benefit of the readers of KNOWLEDGE. There is certainly a change in the character of the spots, as well as in the latitudes at which spots generally appear during different parts of the sun-spot period, as is well illustrated by the diagram taken from the *Monthly Notices*, in which the thick black lines correspond to the areas of sun-spots in different heliographic latitudes as measured at Greenwich from the years 1874 to 1888. It will be seen that after a period of quiescence the spots break out in comparatively high latitudes, and that they gradually approach the region of the solar equator as the period of disturbance runs down.

THE FACE OF THE SKY FOR JANUARY.

BY HERBERT SADLER, F.R.A.S.

SOLAR spots are steadily increasing in number and magnitude. Conveniently observable minima of Algol occur on the 5th at 10h. 0m. P.M.; on the 8th at 6h. 49m. P.M.; on the 25th at 11h. 42m. P.M.; on the 28th at 8h. 31m. P.M., and on the 31st at 5h. 20m. P.M.

Mercury is an evening star during the first portion of the month, and a morning star during the last portion; but owing to the planet's southern declination he is not well situated for observation in January. On the 1st of January he sets at 5h. 35m. P.M., 1h. 35m. after sunset, with an apparent angular diameter of $7\frac{1}{2}''$, and a southern declination of 20° 40′. About $\frac{52}{100}$ of the disc is illuminated, and he equals a standard second magnitude star in brightness. The illuminated portion of the disc and the apparent brightness of the planet decrease rapidly till the 13th, when he comes into inferior conjunction with the Sun. On the 31st he rises at 6h. 20m., 1h. 23m. before the Sun, with an apparent diameter of $7\frac{1}{2}''$, and a southern declination of 20° 43′. Just one-half of the disc is then illuminated, and the planet will be about equal to a fourth-magnitude star in brightness. During the month he passes from Capricornus into Sagittarius, but without approaching any bright star very closely. Venus is a morning star throughout January. On the 1st she rises at 4h. 59m. A.M., or 3h. 9m. before the Sun, with an apparent diameter of 47″, and a southern declination of 16° 49′, $\frac{20}{100}$ of the disc being illuminated. She is in perihelion and at her greatest brilliancy on the 8th, when about $\frac{26}{100}$ of the disc is illuminated. On the 31st she rises at 4h. 37m. A.M., or 3h. 6m. before the Sun, with an apparent diameter of $29\frac{1}{2}''$, and a southern declination of 19° 8′. About $\frac{43}{100}$ of her disc is then illuminated, and her brightness is about five-sixths of what it was on the 8th. She is in Ophiuchus during the month. On the 17th, at about 5h. 30m. A.M., an 8·7 magnitude star will be about 10″ north of the planet, and at about 5h. 0m. A.M. on the 29th the planet will probably occult a $9\frac{1}{2}$ magnitude star. Both Mars and Jupiter are, for the observer's purposes, invisible throughout the month.

Saturn is an evening star, rising on the 1st at 9h. 51m. P.M., with an apparent equatorial diameter of $18\frac{1}{4}''$ (the major axis of the ring being $42\frac{1}{4}''$ and the minor 1·6″), and a northern declination of 6° 53′. On the 31st he rises at 7h. 47m. P.M., with an apparent equatorial diameter of 19·1″ (the major axis of the ring being 44·0″ and the minor 2·1″), and a northern declination of 7° 24′. At 1h. 1m. on the 6th, Titan will be in transit over the planet. At about 7h. A.M. on the 13th, Titan will be occulted by Saturn. At about 5h. P.M. on the 16th, Iapetus will be about 56″ due north of the planet. At 11h. 30m. P.M on the 21st, Titan will graze the northern limb of Saturn. At about 5h. A.M. on the 30th, Titan will be about 10″ south of the centre of the planet, just outside his disc. At about 9h. P.M. on the 27th, a $9\frac{1}{2}$ magnitude star will be about 78″ south of Saturn. Saturn describes a short retrograde path in Leo to the S.E. of σ Leonis. Uranus does not rise till after midnight on the last day of the month. Neptune is an evening star, rising on the 1st at 1h. 36m. P.M. with an apparent diameter of 2·6″, and a northern declination of 19° 5′. On the 31st he rises at 11h. 37m. A.M., with a northern declination of 19° 22′. He describes a short retrograde path between ϵ and ϖ Tauri during the month.

January is a favourable month for shooting stars, the most noted shower being that of the *Quadrantids*, the radiant point being in R.A. 19h. 12m., and 53° north declination, the greatest display being visible during the morning hours of January 1st to 3rd.

The moon enters her last quarter at 10h. 12m. A.M. on the 3rd; is new at 3h. 25m. P.M. on the 10th; enters her first quarter at 6h. 18m. A.M. on the 17th, and is full at 0h. 25m. A.M. on the 24th. She is in perigee at 1h. 50m. A.M. on the 12th (distance from the earth 223,785 miles), and in apogee at 3h. 50m. P.M., on the 27th (distance from the earth 252,470 miles). The greatest eastern libration is at 5h. 15m. A.M. on the 6th, and the greatest western at 6h. 18m. A.M. on the 18th. In this and following numbers of KNOWLEDGE the occultations of stars and planets will be reckoned from the true north, in the direction N.E.S.W., as in double star measures.

At 5h. 28m. A.M. on the 5th the $6\frac{1}{2}$ magnitude star 2 Libræ will disappear at an angle of 164°, and reappear at 6h. 25m. A.M. at an angle of 262°. The 4th magnitude star ω^1 Scorpii will disappear at 5h. 20m. A.M. on the 7th at an angle of 161°, and reappear at 6h. 6m. A.M. at an angle of 249°, while the $4\frac{1}{2}$ magnitude star ω^2 Scorpii will make a near approach at 6h. 8m. A.M. at an angle of 205°. At 6h. 29m. P.M. on the 13th the $4\frac{1}{2}$ magnitude star τ^1 Aquarii will disappear at an angle of 106° (this star has an amethyst 9th magnitude companion at 28·5″ distance), and reappear at 7h. 11m. P.M. at an angle of 196°. At 7h. 28m. P.M. the same evening the 4th magnitude star τ^2 Aquarii will disappear at an angle of 63°, and reappear, the moon being below the horizon of Greenwich, at 8h. 24m. P.M. At 3h. 29m. P.M. on the 17th the $4\frac{1}{2}$ magnitude star ξ^1 Ceti will disappear in broad daylight at an angle of 81°, and reappear at 4h. 33m. P.M. at an angle of 215°. The same evening the $5\frac{1}{2}$ magnitude star ξ Arietis will disappear at 11h. 5m. P.M. at an angle of 57°, and reappear at 6m. after midnight at an angle of 259°. The 7th magnitude star B.A.C. 755 will disappear at 0h. 2m. A.M. on the 18th at an angle of 108°, and reappear at 0h. 47m. A.M. at an angle of 211°. The 6th magnitude star ω^1

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Tauri will disappear at 11h. 44m. P.M. at an angle of 59°, and reappear at 0h. 48m. the next morning at an angle of 275°. The planet Neptune will disappear at 3h. 13m. A.M. on the 20th at an angle of 128°, and reappear at 3h. 50m. A.M. at an angle of 213°. At 3h. 46m. P.M. on the 22nd the 7th magnitude star B.A.C. 2154 will disappear at an angle of 64°, and reappear at 4h. 41m. P.M. at an angle of 279°. At 5h. 25m. A.M. on the 23rd the 5½ magnitude star ω Geminorum will disappear at an angle of 173°, and reappear at 5h. 39m. at an angle of 202°. At 3h. 27m. A.M. on the 24th the 4½ magnitude star γ Cancri will make a near approach at an angle of 200°. At 3h. 14m. A.M. on the 27th the 6th magnitude star 42 Leonis will disappear at an angle at 96°, and reappear at 4h. 24m. A.M. at angle of 322°. At 10h. 56m. P.M. on the 28th the 4½ magnitude star ν Virginis will disappear at an angle of 118°, and reappear 7 minutes after midnight at an angle of 296°. At 6h. 59m. A.M. on the 31st the 6th magnitude 65 Virginis will make a near approach at an angle of 31°.

The following phenomena are for Washington mean-time (Washington is 5h. 8m. 12s. W. of Greenwich. Minima of Algol, January 1st, 8h. 3m.; 5th, 4h. 52m.; 21st, 10h. 45m.; 25th, 6h. 34m.

OCCULTATIONS.

Star.	Magnitude.	Date. Disappearance.	Angle.	Date. Reappearance.	Angle.
39 Ophiuchi...	5·5	8d. below horiz.		5d. 0h. 40m.	227°
B.A.C. 755 ...	7·0	17d. 5h. 11m	83°	17d. 6h. 23m.	207°
ω¹ Tauri ...	6·0	19d. 4h. 45m.	27°	19d. 5h. 50m.	278°
Geminorum	6·7	21d. 13h. 37m.	148°	21d. 14h. 19m.	220°
ι (46) Leonis	5·7	26d. 15h. 46m.	99°	26d. 16h. 57m.	326°
65 Virginis ...	6·1	30d. 12h. 4m.	197°	30d. 12h. 19m.	222°
l^2 Virginis ...	5·1	30d. 18h. 21m.	139°	30d. 19h. 40m.	289°

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

DUPLICITY OF WEGA.

In reply to the question whether Monsieur Paul Henry or his brother were able to confirm Mr. Fowler's observation as to the duplicity of Wega, M. Paul Henry writes on the 17th December :—

CHER MONSIEUR,—J'ai vu dans les "Monthly Notices" la note de Mr. Fowler concernant la duplicité de α Lyra. En ce qui nous concerne, nous avons obtenu à differentes dates, et à l'aide de notre prisme en flint de 45°, trois photographies du Spectre de Wega, qui toutes trois montreait la raie K *simple et étroite*, tandis que H qui, comme on sait, est composée de deux raies appartenant l'une à l'hydrogène et l'autre au calcium, est *très-nettement* double. La longueur de notre Spectre, mesurée de F à K est de 75 mill. (3 inches). Si Wega est réellement une étoile double, il faut croire que nous avons été assez "unhappy" pour obtenir sa photographie au moment où la vitesse de les composantes était presque nulle, dans la direction du mouvement visuel.

Si le ciel n'avait pas été aussi couvert nous aurions à nouveau fait quelques autres Spectres de cette étoile. . . .

P. HENRY.

SNOW IN MARS.

To the Editor of KNOWLEDGE.

SIR,—In your interesting article on the Moon in the last number of KNOWLEDGE you allude to the waning and waxing of the snow at the poles of Mars during the summer and winter of those regions. It has always been a puzzle to me how sufficient heat to melt snow could reach Mars, seeing that the intensity of light and of the sun's heat must diminish inversely as the square of the distance from the central source, and, moreover, seeing that Mars is so much smaller than our own planet, with a length of day nearly equal to our own.

Yours, &c.,

Tynron, Dumfriesshire. J. SHAW.

[Following terrestrial analogies, it has usually been assumed that the white polar caps of Mars are due to snow, and I do not feel that the assumption is unreasonable. One would expect the temperature of the surface of Mars to depend on the depth of the planet's atmosphere as well as on the distance of Mars from the sun, and the internal heat of the planet. If Mars has been cooling as long or longer than the earth, I agree with Mr. Shaw that, owing to the larger proportion of cooling surface to cooling mass we might expect to find the internal temperature of Mars less than the internal temperature of the earth at a similar depth below the surface. But the temperature at 20 miles below the surface of Mars may be much greater than the temperature at 10 miles below the earth's surface, and the depth of the atmosphere is evidently an important element which must not be neglected in estimating the depth below the cooling surface.—A. C. RANYARD.]

MAGIC SQUARES.

To the Editor of KNOWLEDGE.

DEAR SIR,—With your kind permission I should like to make a few remarks on the interesting article on Magic Squares in the December number of KNOWLEDGE; but I desire to state at the outset that I think the better plan is to adhere to the time-honoured definition of a magic square, viz. that such a square consists of integers, and that the two central diagonals must give the same summation as the rows and columns. To widen the definition now would, it seems to me, be very inconvenient, rendering all that has been written on the subject in the past liable to misconstruction. It is as if it were proposed that, for the future, the word "chess" should be applied to all games played on a chess-board. All the difficulty, and therefore all the charm, of magic squares lies in making the diagonals sum correctly. A square without diagonals is so easily made that the whole subject could be treated of in a paragraph. On the other hand, I admit that a magic square need not be composed of consecutive numbers, nor, indeed, of numbers in any symmetrical progression whatever.

Now, although the samples given on pp. 278, 279 are proper magic squares with diagonals, yet the directions given for making them will not necessarily give such. For example, we are told to "commence by arranging a square of consecutive numbers so that no figure occurs twice in the same line or column" (p. 278). No order in which they are to appear is mentioned; and rightly, if only diagonal-less squares are required; but if diagonals are wanted, the rule given will not be found a sufficient guide. For example, if the primary square of three, numbered (1), be arranged so that the top row is 1 2 3 or 3 2 1, instead of 1 3 2, the resulting square will be without diagonals. Not only this, but in one instance the complete rule might fail in even obtaining a square of the diagonal-less kind. This is owing to the method of turning a similar square one-quarter round, instead of adhering to De la Hire's way for odd roots.

1	2	3	4	5
3	4	5	1	2
5	1	2	3	4
2	3	4	5	1
4	5	1	2	3

(1)

4	2	5	3	1
5	3	1	4	2
1	4	2	5	3
2	5	3	1	4
3	1	4	2	5

(2)

For example, (1) is strictly made according to rule; no figure appears twice in the same line or column. (2) is the same square turned one-quarter round. But on superimposing according to the instructions given, we get a square with repetitions.

14	22	35	43	51
35	43	51	14	22
51	14	22	35	43
22	35	43	51	14
43	51	14	22	35

(3)

There are only five different numbers in the whole figure, each line containing the same numbers, though in a different order.

In these remarks I am alluding specially to those squares whose roots are prime numbers. [To refer to squares with even or other composite roots would require more room than would be permissible in a letter.] Those who may have read Hutton's *Mathematical Recreations*, may recollect that Ozanam (or Montucler) describes De la Hire's process for odd (prime) roots as consisting of the super-position of two differently arranged primary squares. Your method described in KNOWLEDGE, p. 278, of using identical squares turned into different positions, is certainly simpler, *where it can be applied* without causing repetitions, the test of which is as follows. Let p be any number less than the root of the square. Then, if p^2+1 is prime to the root, the square may be turned without fear of repetitions. Otherwise there is a possibility of their occurring. Thus, 2^2+1 is *not* prime to 5; nor is 5^2+1 prime to 13; nor 4^2+1 to 17; nor 12^2+1 to 29; consequently the simpler method of identical squares with one turned $\frac{1}{4}$-round, will, at least, sometimes fail with the squares of 5, 13, 17, 29; but will always succeed with the roots, 7, 11, 19, 23, as every value of p^2+1 is prime to these latter numbers.

I will not in this letter touch on the concluding portion of the paper, except to say that Mr. Frost's articles on the subject, though extremely valuable in suggestive matter, are liable to be misunderstood for want of clearer explanation. I may, perhaps, on a future occasion be favoured with an opportunity of returning to the subject.

New Athenæum Club, T. S. BARRETT.
12th December 1890.

[We need some name for the magic squares whose diagonals do not sum magically. If we adopt Mr. Barrett's definition, and treat as the only true and orthodox magic squares those which have such diagonal summations, we shall need some further class names for the still more perfect varieties of magic square with magic summations parallel to the diagonals, and with knight's move sequences, &c. I was anxious to cut down the length of my article, and therefore omitted to mention the complicated rules given by La Hire for building skeleton forms, so as to avoid the repetition of numbers when the rows are turned into columns and the numbers are multiplied by the root and added to the corresponding numbers of the original skeleton form. If the diagonals of the skeleton form are made to sum magically, it is evident that the diagonals of the resulting square will also sum magically. Mr. Barrett's law for determining whether there will be such repetitions strikes me as very neat.

In order to avoid repetitions with a skeleton square of 5, such as that instanced by Mr. Barrett, the numbers in the first row may be written down in any order as **1 2 4 5 3.** The row immediately below it is made by repeating the numbers in the same order, beginning with the second or last, that is, the fifth number, and so on for the remaining rows; thus—

1	2	4	5	3
2	4	5	3	1
4	5	3	1	2
5	3	1	2	4
3	1	2	4	5

In the instance I have taken, the two diagonals each sum magically, giving a total of 15, similar to that of the rows and columns. The square may be turned round through a right-angle, and it still remains magic, with magically summing diagonals. Each of the elements of the original skeleton form may be multiplied by 5, and may be added to the corresponding elements of the turned-about skeleton square, and the compounded square will evidently still retain its qualities of summing magically in rows, columns, and diagonals; thus—

5	10	20	25	15		3	5	4	2	1
10	20	25	15	5		1	3	5	4	2
20	25	15	5	10	and	2	1	3	5	4
25	15	5	10	20		4	2	1	3	5
15	5	10	20	25		5	4	2	1	3

give when added cell to cell

8	15	24	27	16
11	23	30	19	7
22	26	18	10	14
29	17	6	13	25
20	9	12	21	28

Take 5 from each number in the compounded square, and we have the magic square with magically summing diagonals,

3	10	19	22	11
6	18	25	14	2
17	21	13	5	9
24	12	1	8	20
15	4	7	16	23

A different rule is necessary for building skeleton forms with oddly even and evenly even edges, if it is desired to make both the diagonals sum magically.

Several readers have written to ask me to explain what was meant by "the scale of 3" and "the scale of 5" in the December number. Numbers may be expressed in any scale in a manner which corresponds with the decimal notation in ordinary use. Thus, if we adopt the scale of 5, the number six will be expressed as 11, that is, one times five added to one. The number seven becomes 12, or one times five plus two. The number ten becomes 15 (or 20 if we use noughts and do not permit 5 to appear), that is, one times five plus five, or twice five plus nought.—A. C. RANYARD.]

RECURRING DECIMAL AND OTHER RADIX FRACTIONS.

To the Editor of KNOWLEDGE.

SIR,—Mr. Chartres and Mr. Willis have again opened up that always interesting subject of recurring decimals—interesting, because apparently mysterious, and mysterious because not fully or generally understood. Mr. Willis has pointed out (KNOWLEDGE, December, p. 273) that r being the radix of the scale of notation, the reciprocals of $nr-1$ have *not* always complementary repetends, giving the instances of 39 and 69, whose repetends, in the decimal scale, are *not* composed of pairs of figures summing

$r-1$, that is, 9. Nor is this alleged law true in other scales of notation. For example: in the scale of 8, 15, which would be $2\,r-1$, has 0421 for repetend. This is not complementary, as $0+2$ and $4+1$ are not equal to $r-1$, or 7.

Now the real law is this, and it is universally true. A number p has a complementary repetend in the scale r, when, and only when, a number x can be found, so that p is a factor of r^x-1, and $r^{\frac{x}{2}}-1$ is a factor of $\frac{r^x-1}{p}$. For example, 7 is a factor of 10^6-1, and 10^3-1 is a factor of $\frac{10^6-1}{7}$; consequently 7 has a complementary repetend, namely 142857, in the decimal scale.

The reason of this is easily shown. In these cases, $\frac{r^x-1}{p}$ is always the repetend itself (divested of preliminary zeros, if any); and being a multiple of $r^{\frac{x}{2}}-1$, must necessarily possess the complementary property. For, to take our example again from the decimal scale, a multiple of 10^n-1 is the same thing as some other number increased by the addition of zeros, minus itself. Thus the repetend of 7 is a multiple of 10^3-1, being 143×999. Consequently, annexing ciphers to 143, and subtracting, produces complementariness in the product.

$$\begin{array}{rr} & 143000 \\ \text{subtract} & 143 \\ \hline & 142857 = \text{repetend of } 7. \end{array}$$

When the nines exceed the other figures in number, zeros must be prefixed to the product to make up the difference. Thus, the repetend of 77 is 13×999.

$$\begin{array}{rr} & 13000 \\ \text{subtract} & 13 \\ \hline & 012987 = \text{repetend of } 77 \end{array}$$

But for one thing, we could tell the properties of the repetend of any given number without having to calculate it. That one thing standing in our way is the impossibility of resolving high numbers into their prime factors. But so far as we can construct a table of the prime factors of r^n-1, we can by inspection learn from it the length of repetends, whether they possess the complementary property, and many other particulars.

In the following table, to save room, I put the index of 10^n-1 only, in the first column; 1 instead of 9, 2 instead of 99, and so on.

Index.	Prime Factors.	
1	3. 3.	
2	3. 3. 11.	
3	3. 3. 3. 37.	
4	3. 3. 11. 101	
5	3. 3. 41. 271.	
6	3. 3. 3. 11. 37. 7. 13.	
7	3. 3.	239. 4649.
8	3. 3. 11. 101.	73. 137.
9	3. 3. 3. 3. 37.	333667.
10	3. 3. 11. 41. 271.	9091.
11	3. 3. *the rest unknown.*	
12	3. 3. 3. 11. 37. 101. 7. 13.	9901.
13	3. 3. *the rest unknown.*	53. 79.
14	3. 3. 11. 909091.	239. 4649.
15	3. 3. 3. 37. 41. 271.	31.2906161.
16	3. 3. 11. 101. 5882353.	73. 137. 17.

If we examine this table we see that when once a prime factor appears we can place it afterwards with ease. Thus 11 appearing for the first time against the 2, it reappears for ever afterwards alternately—viz. against every even index; 37, appearing at first in the third line, reappears in the 6th, 9th, &c. And so with all the other factors. The index shows the length of repetends; 37 appears at first against the index 3, hence its repetend consists of three figures. Similarly with the products of factors; 7 and 13 both appear for the first time in the sixth line, consequently not only their repetends have six figures, but also the repetends of any of the products obtained by multiplying either of them by any of the other factors in the same line. By this means we can ascertain up to a certain point exactly how many numbers have repetends of a given length. For example, we find that exactly fifty-three numbers, and no more, have repetends consisting of six figures; that only thirty-six numbers have 8-figure repetends; that 9-figure periods are possessed by only twelve numbers, whilst the repetends of just 186 numbers have twelve figures. I need scarcely lengthen this already long letter by pointing out how the table may be used for ascertaining whether a repetend has the complementary property. It is easily seen, when we consider the fact that every one of the factors of r^n-1 reappear as factors of $r^{2n}-1$; and that when n is an even number, $r^{\frac{n}{2}}-1$ is always a factor of r^n-1. For $r^n-1=(r^{\frac{n}{2}}-1)(r^{\frac{n}{2}}+1)$. All this applies equally to every scale of notation, as may easily be seen on constructing a table of the prime factors of r^n-1 for any scale that may be chosen.

T. S. BARRETT.

New Athenæum Club,
11 Dec. 1890.

Whist Column.

BY F. S. HUGHES, B.A.Cantab.

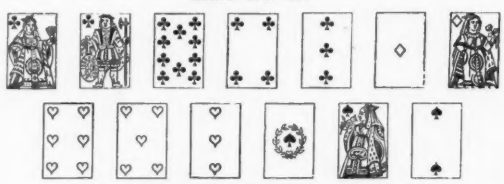
PLAYING TO THE SCORE.

IN former numbers of KNOWLEDGE the difficulty has been pointed out of laying down definite rules for the management of trumps. It is a very vexed question what degree of strength is required to justify a call for trumps, and the difficulty is accentuated by the necessity of always playing to the score.

Just as a lead from one trump may sometimes be right, so a call from a very weak trump hand may be the means of saving or making the game.

The following hand, based on actual play, illustrates the success of a call from a very weak trump hand.

HAND NO. 17.



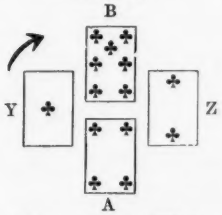
A's Hand.

Score—Three all.

A turns up the 3 of hearts.

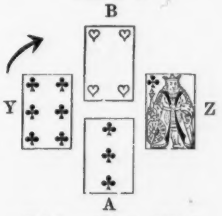
NOTE.—A and B are partners against Y and Z. Y has the first lead; A is the dealer. The card of the leader to each trick is indicated by an arrow.

TRICK 1.



Tricks—AB, 0; YZ, 1.

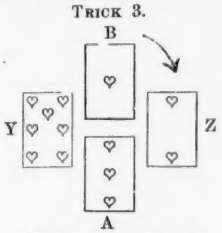
TRICK 2.



Tricks—AB, 1; YZ, 1.

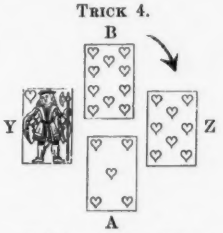
NOTES.—*Trick* 1.—From his lead Y has at least five clubs, so that B and Z cannot have more than three between them. The king must therefore fall in the second round, and A's suit will be established. As the score is three all, A reasons that, unless his partner has two honours, they must score two by tricks to save the game, and, moreover, his partner's hand, whatever it may be, is very unlikely to be prejudiced by trumps being out. Therefore, having his suit established, and strong defence in diamonds and spades, he considers that he is justified in calling, although he only holds three small trumps. *Trick* 2.—Y leads the 6 of clubs, the penultimate, B ruffs a doubtful trick, thereby showing that he is weak in trumps, and A completes his call.

TRICK 3.



Tricks—AB, 2; YZ, 1.

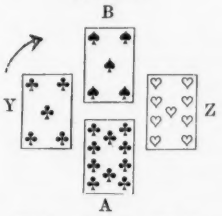
TRICK 4.



Tricks—AB, 2; YZ, 2.

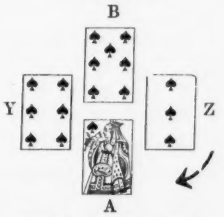
NOTE.—*Trick* 4.—B has only one honour, and probably no more trumps. The king or queen of trumps is probably in Z's hand.

TRICK 5.



Tricks—AB, 2; YZ, 3.

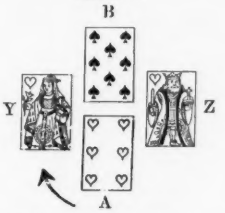
TRICK 6.



Tricks—AB, 3; YZ, 3

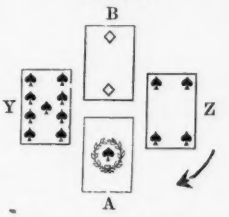
NOTES.—*Trick* 5.—Y evidently wants Z to make his trump separately. *Trick* 6.—To save the game, A and B must make six of the remaining tricks, and A, therefore, puts on the queen of spades second in hand.

TRICK 7.



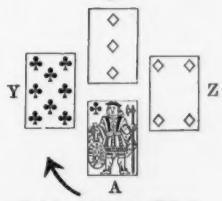
Tricks—AB, 3; YZ, 4.

TRICK 8.



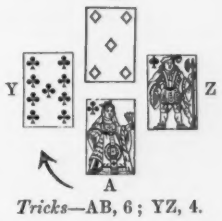
Tricks—AB, 4; YZ, 4.

TRICK 9.



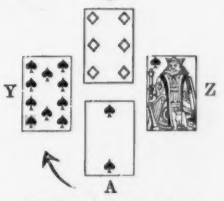
Tricks—AB, 5; YZ, 4.

TRICK 10.



Tricks—AB, 6; YZ, 4.

TRICK 11.



Tricks—AB, 6; YZ, 5.

NOTE.—*Trick* 11.—A can, by the fall of the cards, place the 10 of spades and two diamonds in Y's hand, and the king of spades and two diamonds in Z's hand. His partner, of course, has three diamonds. If Y has the king of diamonds AB cannot save the game. But if the king is with Z, then A, by leading the losing spade, secures the tenace over him in diamonds.

A makes the two remaining tricks, and
AB WIN THE GAME.

A's Hand.	B's Hand.
C.—Qn, Kn, 10, 4, 3.	C.—7.
D.—Ace, Qn.	D.—9, 7, 6, 5, 3, 2.
S.—Ace, Qn, 2.	S.—8, 7, 5.
H.—6, 5, 3.	H.—Ace, 10, 4.

Y's Hand.	Z's Hand.
C.—Ace, 9, 8, 6, 5.	C.—Kg, 2.
D.—Kn, 8.	D.—Kg, 10, 4.
S.—10, 9, 6.	S.—Kg, Kn, 4, 3.
H.—Qn, Kn, 7.	H.—Kg, 9, 8, 2.

REMARKS.—*Trick* 1.—Before A plays a card he sees that his suit of clubs will be established, and that he has, therefore, a very strong hand in plain suits. His call for trumps is therefore very good, but it must be remarked that prior to Y's lead there was absolutely no justification for a call. Beginners should note that this is a case of exceptional play, and should bear in mind the remarks on the subject in the Whist Column of the December number of KNOWLEDGE. *Trick* 5.—Y's play is perhaps a little doubtful. He can place the king of trumps in his partner's hand, and he is anxious to avoid the risk of the two honours falling together, as would probably happen if A gets in to lead another trump. But as A cannot have had more than 4 trumps to the nine when he called, it is possible that Z has another trump besides the king. If this be the case, it is undesirable to force him. *Trick* 6.—A's play is very good here. If Y has the king of spades the game is almost certainly lost. The only doubt there can be as to A's play is whether he should not play the ace so as to ensure the king and queen of trumps falling together in case Y has the king of spades. It is, however, on this hypothesis very improbable that he would afterwards make the queen, as his partner has shown weakness in spades, and the game would then be lost.

XUM

Chess Column.

(CONDUCTED BY I. GUNSBERG.)

ANSWERS TO CORRESPONDENTS.

By G. H. D. GOSSIP.

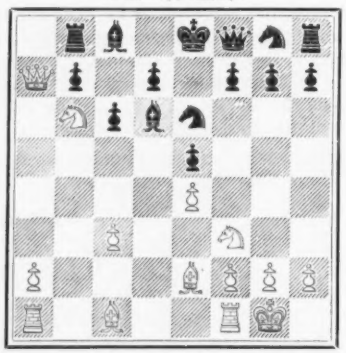
M. N. KUKA (PARSEE), BOMBAY.—Your analysis is interesting and well worked out; but its value is lessened to some extent by the fact that White is not compelled to play 4. Kt×P. He may simply play 4. P to QB3, and whatever Black play now, we prefer the White. An analogous position to the variation you give is arrived at by 1. P to K4, P to K4; 2. Kt to KB3, P to Q4; 3. Kt×P, P×P; 4. B to B4, Q to Kt4, &c. Moreover, after 1. P to K4, P to K4; 2. Kt to KB3, Kt to QB3; 3. B to B4, Kt to Q5; 4. Kt×Kt, P×Kt; 5. P to Q3 or Castles, yields White much the better game, the position in this case being similar to the one arrived at in Bird's worthless defence to the *Ruy Lopez*, with the difference in White's favour of his Bishop being at QB4 instead of QKt5.

The great match by correspondence between Steinitz and Tschigorin, which arouses universal interest, is adjourned *pro tem.*, owing to the match over the board now being played in New York between Steinitz and Gunsberg. The subjoined diagrams illustrate the positions in each game:—

"Evans Gambit."

Position after Black's 17th Move.

BLACK (Steinitz).



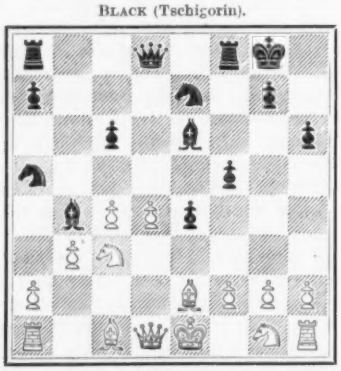
WHITE (Tschigorin).

In our last number, we confidently predicted the victory of Black (Steinitz) in the above Game I., and are glad to find our opinion confirmed by Steinitz himself, who expresses his confidence in a favourable result. The general opinion, even amongst the experts, or so-called "masters," in London was that White (Tschigorin) had a winning position. A careful examination of the position, however, will show that Black, although cramped, will be able to wriggle out of his apparent difficulties and remain with the better game for the ending.

"Two Knights' Defence."

Position after Black's 18th Move.

BLACK (Tschigorin).



WHITE (Steinitz).

Again, although Black has the better position and development, his Pawns on the Queen's flank are broken up and badly posted for the ending; whereas White's Pawns are excellently situated. We do not think Black can hope now for more than a draw at the best. On his 14th move in Game II. White played P to QB3. Steinitz points out that P to QB4 would have been inferior on account of Black's rejoinder Kt to B3, White having a "hole" in his game at Q4; whereas White's 15th move, P to Q4, creates a hole at Black's Q to B5; for if 15. P×P; 16. P×P, Q to K2; 17. K to Bsq! with the better game.

According to latest advices, the score in the Steinitz-Gunsberg match stands Gunsberg 2, Steinitz 1, and 2 draws.

The following interesting skirmish was played in the late Breslau Tourney:—

"Petroff's Defence."

WHITE. Schallopp.	BLACK. Mieses.	WHITE. Schallopp.	BLACK. Mieses.
1. P to K4	P to K4	12. P×Kt	P to QB3
2. Kt to KB3	Kt to KB3	13. P to KR3	B to R4 (*d*)
3. Kt×P (*a*)	P to Q3	14. Q to Kt3	Q to B2? (*e*)
4. Kt to KB3	Kt×P	15. R to QKtsq	P to QKt3
5. P to Q4	P to Q4	16. Kt to K5	B to Q3
6. B to Q3	B to K2	17. P to KB4	K to R sq
7. Castles	Castles	18. P to Kt4	B to Kt3
8. P to B4	Kt to KB3	19. P to B5	P to B3
9. Kt to B3	B to KKt5 (*b*)	20. Kt×B (ch)	P×Kt
10. P×P	Kt×P	21. P×P	Q to K2
11. B to K4! (*c*)	Kt×Kt	22. R to B5 (*f*)	Resigns

(*a*) Steinitz prefers 3. P to Q4.
(*b*) P×P would have been stronger play.
(*c*) White now gets a fine game.
(*d*) It would have been better to take the Kt.
(*e*) Weak. Q to Kt3 was preferable, *e.g.* 14. Q to Kt3; 15. R to QKtsq, Q×Q; 16. R×Q, P to KB4, &c.
(*f*) Finished in Schallopp's usual brilliant style.

The final result of Simpson's Divan Tourney of 19 competitors was as follows: Lee and Muller, *ex æquo*, 14, tied for 1st and 2nd prizes; Gossip, 12, took 3rd prize; Curnock, 11 (2nd class), won 4th prize, and Mortimer and Van Vliet, 10½ each, tied for 5th prize. It will thus be seen that four of the five prizes were won by first-class players. We give the full result, because none of the London Chess Editors, with two or three exceptions, have done so; and two reports of the aforesaid Tourney stated that the 3rd prize winner won two of his games by forfeiture, but omitted to mention that every one of the other prize winners (except Curnock) also won games by forfeiture, thus leading the public to suppose the success of the winner of the 3rd prize to be due to luck rather than to skill.

A portrait of Mr. Donisthorpe, with an interesting sketch of his chess career, appears in the December number of the *Chess Monthly*. His record of successes is given as follows: He beat in set matches Lee, by 5 to 3; Fisher (winner of 2nd prize in the Vizayanagaram Tourney of 1883), by 5 to 2; Gattie (amateur champion of England), by 5 to 4; Mortimer, by 9 to 6; Anger, by 5 to 1; and won the Ruskin prize at the Congress of the *British Chess Association* in 1887.

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